Senior 4 Applied Mathematics (40S)
Standards Test

Written Test

January 2006

Manitoba

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SENIOR 4 APPLIED MATHEMATICS (40S)
STANDARDS TEST

DESCRIPTION

Total Possible Marks: 53 **Time: 2.5 hours**

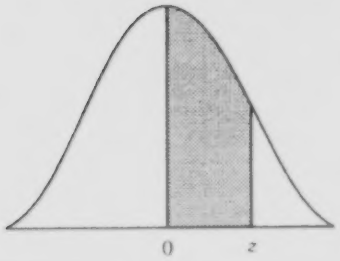
This test consists of two sections:

	Description	Suggested Time to Complete	Marks
Section A	7 multiple-choice questions worth 1 mark each	20 minutes	7
Section B	13 constructed-response questions worth from 2 to 5 marks each	130 minutes	46

TEST RESOURCES AND DIRECTIONS

- You are provided with the Standard Normal Distribution table (see page 2).
- You may consult your 8½" × 11" individually prepared study sheet during the test.
- Use of a graphing calculator, computer software or a Website is allowed.
- Use of protractor, compass and ruler are allowed.
- Read all instructions on the test carefully.
- In Section A, choose the best response and mark it on the *Answer/Scoring Sheet*. Do not fold the *Answer/Scoring Sheet* or the test booklet.
- If you need more space to answer a question, extra pages may be provided by your teacher. Write your booklet ID number and question number on any extra page(s) used and staple it into the booklet where your answer begins. Indicate in the response space of the question that the answer is on a separate sheet.

z-Score Chart



Notes:

1. For values of z above 3.09, use 0.4999 for the area.
2. Use these common values that result from interpolation:

z-score	area
1.645	0.4500
2.575	0.4950

The Standard Normal (z) Distribution

z	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
0.0	0.0000	0.0040	0.0080	0.0120	0.0160	0.0199	0.0239	0.0279	0.0319	0.0359
0.1	0.0398	0.0438	0.0478	0.0517	0.0557	0.0596	0.0636	0.0675	0.0714	0.0753
0.2	0.0793	0.0832	0.0871	0.0910	0.0948	0.0987	0.1026	0.1064	0.1103	0.1141
0.3	0.1179	0.1217	0.1255	0.1293	0.1331	0.1368	0.1406	0.1443	0.1480	0.1517
0.4	0.1554	0.1591	0.1628	0.1664	0.1700	0.1736	0.1772	0.1808	0.1844	0.1879
0.5	0.1915	0.1950	0.1985	0.2019	0.2054	0.2088	0.2123	0.2157	0.2190	0.2224
0.6	0.2257	0.2291	0.2324	0.2357	0.2389	0.2422	0.2454	0.2486	0.2517	0.2549
0.7	0.2580	0.2611	0.2642	0.2673	0.2704	0.2734	0.2764	0.2794	0.2823	0.2852
0.8	0.2881	0.2910	0.2939	0.2967	0.2995	0.3023	0.3051	0.3078	0.3106	0.3133
0.9	0.3159	0.3186	0.3212	0.3238	0.3264	0.3289	0.3315	0.3340	0.3365	0.3389
1.0	0.3413	0.3438	0.3461	0.3485	0.3508	0.3531	0.3554	0.3577	0.3599	0.3621
1.1	0.3643	0.3665	0.3686	0.3708	0.3729	0.3749	0.3770	0.3790	0.3810	0.3830
1.2	0.3849	0.3869	0.3888	0.3907	0.3925	0.3944	0.3962	0.3980	0.3997	0.4015
1.3	0.4032	0.4049	0.4066	0.4082	0.4099	0.4115	0.4131	0.4147	0.4162	0.4177
1.4	0.4192	0.4207	0.4222	0.4236	0.4251	0.4265	0.4279	0.4292	0.4306	0.4319
1.5	0.4332	0.4345	0.4357	0.4370	0.4382	0.4394	0.4406	0.4418	0.4429	0.4441
1.6	0.4452	0.4463	0.4474	0.4484	0.4495	0.4505	0.4515	0.4525	0.4535	0.4545
1.7	0.4554	0.4564	0.4573	0.4582	0.4591	0.4599	0.4608	0.4616	0.4625	0.4633
1.8	0.4641	0.4649	0.4656	0.4664	0.4671	0.4678	0.4686	0.4693	0.4699	0.4706
1.9	0.4713	0.4719	0.4726	0.4732	0.4738	0.4744	0.4750	0.4756	0.4761	0.4767
2.0	0.4772	0.4778	0.4783	0.4788	0.4793	0.4798	0.4803	0.4808	0.4812	0.4817
2.1	0.4821	0.4826	0.4830	0.4834	0.4838	0.4842	0.4846	0.4850	0.4854	0.4857
2.2	0.4861	0.4864	0.4868	0.4871	0.4875	0.4878	0.4881	0.4884	0.4887	0.4890
2.3	0.4893	0.4896	0.4898	0.4901	0.4904	0.4906	0.4909	0.4911	0.4913	0.4916
2.4	0.4918	0.4920	0.4922	0.4925	0.4927	0.4929	0.4931	0.4932	0.4934	0.4936
2.5	0.4938	0.4940	0.4941	0.4943	0.4945	0.4946	0.4948	0.4949	0.4951	0.4952
2.6	0.4953	0.4955	0.4956	0.4957	0.4959	0.4960	0.4961	0.4962	0.4963	0.4964
2.7	0.4965	0.4966	0.4967	0.4968	0.4969	0.4970	0.4971	0.4972	0.4973	0.4974
2.8	0.4974	0.4975	0.4976	0.4977	0.4977	0.4978	0.4979	0.4979	0.4980	0.4981
2.9	0.4981	0.4982	0.4982	0.4983	0.4984	0.4984	0.4985	0.4985	0.4986	0.4986
3.0	0.4987	0.4987	0.4987	0.4988	0.4988	0.4989	0.4989	0.4989	0.4990	0.4990

SECTION A: MULTIPLE-CHOICE QUESTIONS

Value: 7 marks **Suggested Time: 20 minutes**

1. Given $R = \begin{bmatrix} 3 & 5 \\ 8 & 7 \end{bmatrix}$. Which matrix results from the matrix operation $R + R^2$?

A) $\begin{bmatrix} 9 & 15 \\ 24 & 21 \end{bmatrix}$

B) $\begin{bmatrix} 12 & 30 \\ 72 & 56 \end{bmatrix}$

C) $\begin{bmatrix} 52 & 55 \\ 88 & 96 \end{bmatrix}$

D) $\begin{bmatrix} 547 & 595 \\ 952 & 1023 \end{bmatrix}$

2. Given the scale 1 cm = 30 km/h, the description of this vector is:

A) 30 km/h at E 30° N

B) 30 km/h at N 30° E

C) 90 km/h at E 30° N

D) 90 km/h at N 30° E

3. Brad has invested $10 000.00. His annual rate of return is 8.50%. What will the value of his investment be at the end of 5 years if the interest is compounded annually?

A) $14 250.00

B) $15 036.57

C) $15 273.01

D) $18 500.00

4. The difference between the value of assets and liabilities is known as:

A) net worth

B) debt equity ratio

C) an investment portfolio

D) a mutual fund

5. There are 24 students in Jane's Applied Mathematics class. Her teacher wants to break the class into groups of 3 students to work on their matrix project.

In how many ways can the first group be formed?

A) 2024

B) 4048

C) 12 144

D) 13 824

6. Tests indicate that the mean life of an electric light bulb in continuous operation is 87 hours with a standard deviation of 7.50 hours.

Assuming a normal distribution in a total of 1000 light bulbs, approximately how many light bulbs will last between 72 and 94.50 hours?

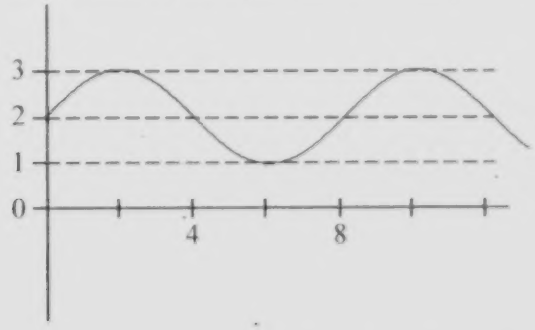
A) 480

B) 680

C) 820

D) 950

7. The graph below is represented by the equation: $y = a\sin(bx - c) + d$.



The value of d is:

A) 1

B) 2

C) 3

D) 8

SECTION B: CONSTRUCTED-RESPONSE QUESTIONS

Value: 46 marks **Suggested Time: 130 minutes**

DIRECTIONS

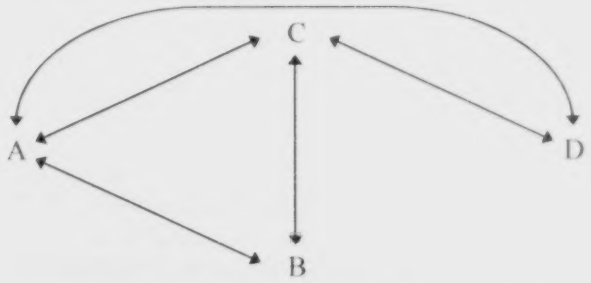
- There are 13 constructed-response questions in this section of the test. Each question is worth from 2 to 5 marks.
- Provide **complete answers** in the spaces provided in the test booklet. You may print out sketches from the computer or your calculator where applicable. Make sure these printouts contain your booklet ID number. Remain seated and your teacher will distribute these printouts to you. Staple the printouts in the booklet where the question begins. Indicate in the response space of the question that the answer is on a printed sheet.
- Provide clear explanations or justifications where applicable. This could be done through labelled diagrams, in words, by showing mathematical operations to verify your answer, or by referencing a software or a calculator program.
  - If you reference a calculator program, indicate your input values.
  - If you reference a spreadsheet, print a copy of the answers.
  - If you reference a software program or a Website, indicate your input values and print or copy the screen showing answers.
- Let the mark values for each question guide your time and the amount of detail you use in your answer. Mark values for subsections of a question are indicated in parentheses.
- Round your final answers to the nearest two decimal places.
- Unless otherwise specified, it is not necessary to draw sketches to scale. If you draw a scale diagram, make sure you indicate your scale.
- An answer without any work shown will be considered incomplete.
- Always state your assumptions.

DO NOT USE

101

8. The following diagram represents the routes that a person can use to drive between the towns labelled A, B, C and D.

Total: 3 marks



a) Create a matrix M which corresponds to the network above.

(1 mark)

b) A student was asked how to calculate the number of ways to travel between two towns going through exactly one other town. The student answered, "$M + M^2$". Explain their error and show the correct answer.

(2 marks)

DO NOT USE

102

9. A paddle wheel boat operator charges the following rates for a two-hour trip: adults—$12.50, students—$8.50 and children under 6 years of age—$2.50. The number of each type of ticket that was sold during the weekend is given in the following matrix:

Total: 2 marks

	Saturday	Sunday
Adults	108	75
Students	84	122
Children	53	72

Determine the boat operator's revenue for each day. Show your work using the appropriate matrix operations.

DO NOT USE

10. Each year at Manitoba High School, the teachers sit on a committee. 103

Total: 4 marks

Currently:

- 30% are on the Sports committee
- 20% are on the Arts committee
- 50% are on the Graduation committee

At the end of the school year, the teachers can change committees.
Here are the changes that took place last June:

- 10% of the teachers from each committee stayed on their committee
- 15% of the members on the Sports committee joined the Graduation committee
- 5% of the members on the Arts committee joined the Sports committee
- 30% of the members of the Graduation committee joined the Arts committee

a) Create a transition matrix which shows the changes in committees.

(2 marks)

$$T = \text{(From)} \begin{matrix} \\ S \\ A \\ G \end{matrix} \begin{matrix} \text{(To)} \\ \begin{matrix} S & A & G \end{matrix} \\ \begin{bmatrix} & & \\ & & \\ & & \end{bmatrix} \end{matrix}$$

b) If this trend continues, determine the percentage of teachers on each committee once it stabilizes. Provide proof of stabilization.

(2 marks)

DO NOT USE

104

11. Marina and Phillip are pulling on a rock with equal force. They are at an angle of 40° to each other.

Total: 4 marks

a) If the resultant vector has a force of 50 newtons, determine the magnitude of the force with which each is pulling. Show your work.

(2 marks)

b) If the resultant force remains at 50 newtons, at what angle could Marina and Phillip pull in order for Marina to pull with double the force of Phillip? Show your work.

(2 marks)

DO NOT USE

12. An airplane travels at a speed of 250 km/h in a direction of 30° north of west for one hour. It then travels at a speed of 300 km/h for 40 minutes in a direction of 42° east of north.

105

To return directly to its starting point, in what direction and what distance must the airplane travel? Show your work.

Total: 4 marks

DO NOT USE

13. Derek is considering a $7500.00 loan amortized over 5 years at an interest rate of 6.50%, compounded monthly. 106

Total: 3 marks

a) What will his monthly payment be?

(1 mark)

b) How much interest will he pay in total over the 5 years? Show your work.

(2 marks)

DO NOT USE

14. The Smith family can purchase a house valued at $100 000.00 with a down payment of $10 000.00, or they could rent a similar house. 107

Total: 5 marks

a) The monthly payment for a mortgage, amortized over 15 years at an interest rate of 6.50% compounded monthly, is $784.00. If the Smiths purchase the house, calculate the total amount paid, including the down payment, by the end of the first 5 years.

(1 mark)

b) Real estate appreciates at a rate of 3% per year. Determine the equity in the purchased house after 5 years. Show your work.

(3 marks)

c) Given that it is more expensive to rent, give one reason why the Smiths would choose to rent.

(1 mark)

DO NOT USE

15. A ship is equipped with 6 flags which are identical except in colour. Of the 6 flags, 3 are red, 2 are blue and 1 is green. Depending on the order of the colour and the number of flags flown, different signals can be sent. 108

Total: 3 marks

a) Using all 6 flags, how many different signals can be sent?

(1 mark)

b) Using only 3 flags, create a sample space showing the different signals that can be made if at least 2 of the flags must be red. State the number of different signals.

(2 marks)

DO NOT USE

16. A group of 480 students at the Manitoba Collegiate Institute are classified by year and mathematics course taken. The following chart shows the result of this classification: 109

Total: 3 marks

	Consumer Mathematics	Applied Mathematics	Pre-Calculus Mathematics
Senior 2	50	60	40
Senior 3	60	70	30
Senior 4	70	70	30

a) What is the probability that a randomly selected student is taking a Consumer Mathematics course?

(1 mark)

b) Consider only Senior 3 and Senior 4 students. What is the probability that a randomly selected student is taking an Applied Mathematics or Pre-Calculus Mathematics course? Show your work.

(2 marks)

DO NOT USE

110

17. The marks for a first year biology course at Zenith University are normally distributed. The professors decided to award final grades using the following system:

Total: 5 marks

- the top 5% of the students will receive an A
- the next 15% of the students will receive a B
- 60% of the students will receive a C
- 15% of the students will receive a D
- 5% of the students will receive an F

Brigitte has a final grade of 77% in the course. The mean is 64% and the standard deviation is 7%.

a) What is Brigitte's z-score?

(1 mark)

b) Find the letter grade that Brigitte will get in the course. Show your work.

(2 marks)

c) With a minimum of a B letter grade, Robert will maintain his basketball scholarship. What is the minimum grade, as a percent, that Robert must obtain in the biology course to earn a B? Show your work.

(2 marks)

DO NOT USE

18. A research study on fruit flies found that an average of 50% of them stay alive after 32 hours. 111

Total: 3 marks

a) Determine the 95% confidence interval for the percentage of a sample of 1000 fruit flies still alive after 32 hours. Show your work.

(2 marks)

b) Explain the meaning of the confidence interval in a).

(1 mark)

DO NOT USE

112

19. The following data represents the sunrise times in Brandon, Manitoba on the first day of each month during the year 2003. Sunrise times are expressed in hours after midnight.

Total: 4 marks

Month/Day	Day of year	Sunrise time (hours)
January 1	1	8.62
February 1	32	8.20
March 1	60	7.38
April 1	91	6.27
May 1	121	5.90
June 1	152	5.60
July 1	182	5.58
August 1	213	6.15
September 1	244	6.92
October 1	274	7.65
November 1	305	7.98
December 1	335	8.25

a) Determine the equation of the sinusoidal curve of best fit for this data.

(2 marks)

b) According to your equation, what is the median sunrise time for the year 2003?

(1 mark)

c) What does one complete cycle represent?

(1 mark)

DO NOT USE

113

20. A stone has become stuck in Justin's bicycle tire. The following equation describes the height of the stone, as compared to the ground, as the tire rotates.

Total: 3 marks

$$h = 30.79\sin(14.47t - 1.87) + 30.79$$

where t represents time in seconds
and h represents the height of the stone above the ground in centimetres.

a) Sketch a graph which represents the height of the stone as a function of time. The graph must start at $t = 0$ and show one second. Label the maximum and minimum values of your graph.

(2 marks)

b) What will the height of the stone be at $t = 1.00$ second?

(1 mark)

END OF TEST

NO MARKS WILL BE AWARDED FOR WORK DONE ON THIS PAGE.

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Senior 4 Applied Mathematics (40S)
Standards Test

Inquiry Task

January 2006

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SENIOR 4 APPLIED MATHEMATICS (40S)
STANDARDS TEST

DESCRIPTION

Total Possible Marks: 19 **Time: 2 hours**

This test consists of two tasks:

	Description	Suggested Time to Complete	Marks
Task 1	Contains a question on Design and Measurement worth 10 marks	60 minutes	10
Task 2	Contains a question on Sequences worth 9 marks	60 minutes	9

TEST RESOURCES AND DIRECTIONS

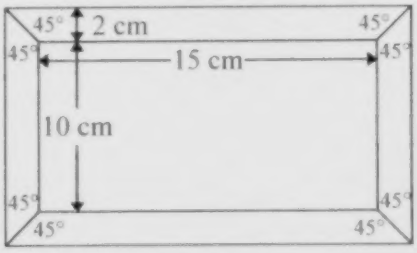
- This test should be written with the assistance of computer software and/or a graphing calculator.
- You may consult your 8½" × 11" individually prepared study sheet during the test.
- If you use a graphing calculator, make sure you indicate all the values you entered in the space provided in this booklet.
- If you use a spreadsheet, print a copy of the answers. Indicate your booklet ID number on the printout. Remain seated and your teacher will distribute this printout to you.
- If you use a Website, make sure you indicate all the values you entered, and print or copy the screen, showing answers.
- Please staple printed copies of all your work on the page of the question. Indicate in the response space of the question that the answer is on a printed sheet.
- Clearly identify the question number on your answer sheet(s) (e.g., Question 2b).
- Always state your assumptions.

DESIGN AND MEASUREMENT

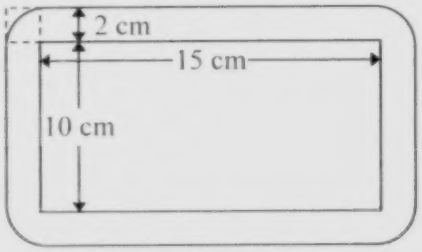
Total: 10 marks

1. The manager for a company that sells wooden picture frames asks you to prepare cost estimates and specific information for the construction of two models of frames. **Model A** is a rectangular frame with square corners and **Model B** is a rectangular frame with rounded corners. Both frames fit pictures that are 10 cm × 15 cm.

Model A



Model B



Here is the information that you will need:

- The wood is 2 cm wide.
- Corners are formed when two pieces of wood are joined which have been cut at a 45° angle.
- The glass which covers the photo must overlap it by 0.50 cm on each side in order to be positioned behind the frame.

a) Determine the minimum length of wood and the minimum area of glass used for one Model A frame. Show how you determined the minimum length of the wood.

(3 marks)

DO NOT USE

b) The company also wants to sell a frame with rounded outside corners called Model B. Calculate the area of wood wasted on each frame to round these corners assuming the curve on each corner is a $\frac{1}{4}$ circle. Show your work.

(2 marks)

c) Glass is purchased in 1 m × 1 m sheets. Determine the maximum number of pieces of glass that can be cut for a Model A frame from a single sheet of glass.

(1 mark)

DO NOT USE

d) Calculate the total cost without taxes to construct the number of Model A frames found in part c) if:

- The wood is purchased in 2 m strips which cost $7.35 per strip.
- Each side of the frame is made from a single piece of wood.
- Glass is sold for $14.00 per square metre (1 m × 1 m).

Show your work.

(3 marks)

e) Calculate the cost to construct each Model A frame. Do not include taxes.

(1 mark)

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DO NOT USE

115

SEQUENCES

2. Jasmine broke her collarbone in a bicycle accident. Her doctor's prescription contains the following information:

Total: 9 marks

- Each pill contains 240 mg of medication.
- Jasmine must take two pills every 12 hours. This represents one dose.
- She must take all 32 pills as prescribed.

a) If her kidneys eliminate 60% of the medication from her body every 12 hours, how much of the medication is in Jasmine's system immediately after she takes the 6^{th} dose? Show your work.

(2 marks)

b) Sketch a graph that represents the sequence for 16 doses. Label the axes.

(2 marks)

DO NOT USE

c) At what level does the medication stabilize in Jasmine's body while she is taking her prescription?

(1 mark)

d) Assuming that Jasmine takes all her medication, how many hours would it take for her kidneys to eliminate the medication after her last dose? Note: The medication has been eliminated when its level in the blood is less than 1 mg. Show your work using data obtained from sequences.

(2 marks)

e) Jasmine visits another doctor for a second opinion before she begins taking any medication. The second doctor informs Jasmine that the quantity of medication in her body must be stabilized between 1000 mg and 1200 mg (inclusive) to eliminate the pain.

Describe a schedule for taking the medication if the pill that Jasmine is prescribed contains 240 mg of medication. Her kidneys still eliminate 60% of the medication from her body every 12 hours. Show your work.

(2 marks)

END OF TEST

NO MARKS WILL BE AWARDED FOR WORK DONE ON THIS PAGE.

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Marking Guide

January 2006

Manitoba

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General Instructions

Organization of Document

Following the general instructions for marking, the document is divided into three sections:

- Answer key for multiple-choice items;
- Marking keys and scoring rubrics for constructed-response items; and
- Marking keys and scoring rubrics for the Inquiry Task.

The first section presents the answers for the multiple-choice items in a table accompanied by the learning outcome(s) associated with each item. In the second section, each test item is presented in bold characters, followed by a series of typical and possible answers. A marking key or scoring rubric details how the marks are to be allocated for each sub-section of the question. Marking keys are used to mark restricted-response items (with or without explanations). Scoring rubrics are to be used for scoring open-response items.

For each question, the item type, the maximum number of marks possible as well as the specific outcomes targeted by the item are identified at the top of the page. Items are presented in the order that they appear on the standards test. Each open-response item as well as each Inquiry Task item is followed by a series of student exemplars. Student exemplars are chosen to exemplify the use of scoring rubrics or marking keys. The mark value allocated and a rationale justifying the mark allocation accompany each student exemplar.

General Marking Instructions

Please make no marks in the test booklets.

Please ensure that:

- each student's final result is recorded, by test booklet number, on the corresponding ***Answer/Scoring Sheet*** (Written Test) and ***Scoring Sheet*** (Inquiry Task);
- the totals are written at the bottom;
- the *Answer/Scoring Sheet* and *Scoring Sheet* are complete and correct;
- a copy has been made for school records; and
- **only a pencil is used to complete the *Answer/Scoring Sheets* and *Scoring Sheets*, by both students and markers.**

Once marking is completed, please forward the *Answer/Scoring Sheets* and *Scoring Sheets* to Manitoba Education, Citizenship and Youth (for more information see the *Administration Manual for Supervising Teachers*).

Scoring the Multiple-Choice Items

Please follow the answer key provided on page 5 of this document.

Types of Student Errors

As a guiding principle, students should only be penalized once for each error committed in the context of a test item. For example, students may choose an inappropriate but still relevant strategy for an item but carry it through correctly and arrive at an incorrect answer. In such cases, students should be penalized for having selected an inappropriate strategy for the task at hand but should be given credit for having arrived at an answer consistent with their choice of strategy.

Please note that for all questions in the vectors unit, allow a flexibility of ±3 mm and ±3° when marking scale diagrams.

Throughout this document, four types of errors have been identified. These are defined briefly below:

Trivial errors:
These are errors for which no marks are to be deducted. In order to be considered trivial, an error must be conceptually unrelated to the learning outcome(s) associated with the item and not lead to a mathematically incorrect answer. Examples include omitting labels, omitting to carry a negative sign in an algebraic task or not rounding final answers.

Technical communication errors:
These are errors of mathematical notation that are conceptually related to the curriculum outcomes. It is important to note, however, that such errors do not prevent students from arriving at a mathematically correct answer.

Examples include:

- incorrect use of brackets on matrices;
- not expressing transition matrices as decimals or percentages;
- missing more than one arrow in a vector diagram;
- not stating a scale when using a scale diagram as a strategy;
- not buying in whole units in the design and measurement unit; and
- "y =" missing when asked for an equation.

In such cases, students are to be penalized no more than a half mark per question for each type of error, and only when the corresponding criteria are awarded.

Minor errors:
These are errors that are generally not conceptual in nature but will inevitably lead to an incorrect answer. In such cases, students are generally penalized one mark depending on the details provided in the marking key or scoring rubric.

Major errors:
These are errors or omissions that are conceptual in nature and clearly reflect a gap in the student's knowledge of the specific learning outcome(s). These types of errors often limit the number of marks that can be awarded to a student's response.

Scoring the Constructed-Response Items

The respective marking key or scoring rubric should be used in conjunction with the ***Senior 4 Mathematics: Manitoba Curriculum Framework of Outcomes and Senior 4 Standards*** (Applied section) when assigning scores to student responses.

Scoring guidelines—Restricted-response items (with or without explanation)

Each item of this type is designed to elicit a well-defined response according to the associated specific outcome(s) and relevant mathematical processes. Their purpose is to determine whether a student meets the standards for the course (level 2) as they relate to the knowledge and skills associated with the item.

To receive full marks, a student's response must be complete and correct. Partial marks may be awarded for a "relevant strategy" with execution errors. **A relevant strategy is defined as one that is consistent with the specific outcome(s) and mathematical processes associated with the item that, if properly executed, would lead to the correct answer.** Where alternative strategies are possible, the marking key makes mention of them.

It is important to note that some items require some form of explanation or justification from students. Such explanations and justifications can take various forms depending on students' learning styles. Therefore, marking of student responses needs to reflect appropriate flexibility in this regard. Test instructions to students have clearly specified that explanations or justifications can be done through labelled diagrams, in words, by showing mathematical operations for answer verification or by referencing software or a calculator program.

Scoring guidelines—Open-response items

These items are designed to elicit student responses at any of the three levels of achievement defined in the *Senior 4 Mathematics: Manitoba Curriculum Framework of Outcomes and Senior 4 Standards* (Applied section). The rubrics contain the language of the curricular standards in order to facilitate scoring in a manner that is consistent with those standards. The recommended procedure for scoring student responses is as follows:

1. Read the relevant specific outcome(s) in the *Senior 4 Mathematics: Manitoba Curriculum Framework of Outcomes and Senior 4 Standards* (Applied section).
2. Read the possible solution(s) provided in this document.
3. Study the student exemplars provided and the rationales for the assigned scores in relation to the marking key.
4. Carefully view all of the student's response and decide which of the three levels of achievement ("exceptional understanding", "good understanding" or "limited understanding") best applies. Whether the response clearly fits into one category or straddles two, this process will narrow down the number of possible scores that can be assigned to the response.
5. Compare the features of the student's response with the general performance indicators accompanying the mark values and the specific performance indicators (criteria) contained in the rubric. Note that the specific performance indicators only typify a student's response in a given score category. An exact match is not anticipated.

Irregularities in Standards Tests

During the administration of standards tests, supervising teachers may encounter irregularities. Markers may also encounter irregularities during local marking sessions. Appendix D provides examples of such irregularities as well as procedures to follow to report irregularities.

If an *Answer/Scoring Sheet* (Written Test) or a *Scoring Sheet* (Inquiry Task) is marked with "NR" and/or "0" only (e.g., student was present but did not attempt any questions) please document this on the *Irregular Test Paper Report*.

Assistance

If, during marking, any issue arises that cannot be resolved locally, please call Manitoba Education, Citizenship and Youth at the earliest opportunity to advise and/or seek assistance. If required, we will connect you to an advisor. Also, please be sure to notify us before making any modifications to the answer/marking keys or scoring rubrics.

Contact person: Barbara Riou, Assessment Consultant, at 945-4035 or toll-free at 1 800 282-8069, ext. 4035

Answer Key
for Multiple-Choice Items

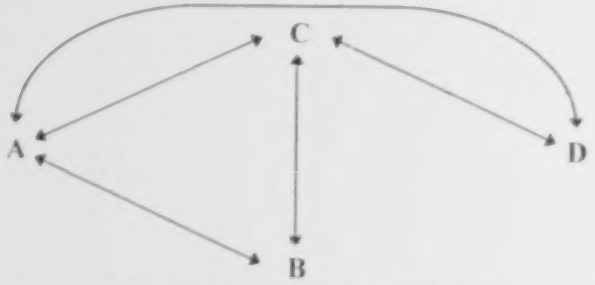
Question No.	Answer	Outcome
1	C	A1
2	D	B1
3	B	C4
4	A	C4
5	A	D2
6	C	E2
7	B	G1

Marking Keys and Scoring Rubrics for Constructed-Response Items

Question No. 8 and Answer

8. The following diagram represents the routes that a person can use to drive between the towns labelled A, B, C and D.

Total: 3 marks



a) Create a matrix M which corresponds to the network above.

(1 mark)

$$M = \begin{array}{c} \\ \text{A} \\ \text{B} \\ \text{C} \\ \text{D} \end{array} \begin{array}{c} \begin{array}{cccc} \text{A} & \text{B} & \text{C} & \text{D} \end{array} \\ \begin{bmatrix} 0 & 1 & 1 & 1 \\ 1 & 0 & 1 & 0 \\ 1 & 1 & 0 & 1 \\ 1 & 0 & 1 & 0 \end{bmatrix} \end{array}$$

b) A student was asked how to calculate the number of ways to travel between two towns going through exactly one other town. The student answered, "$M + M^2$". Explain their error and show the correct answer.

(2 marks)

$M + M^2$ means going through at most one other town.

M^2 means going through exactly one town.

OR

M^2

$$M^2 = \begin{array}{c} \\ \text{A} \\ \text{B} \\ \text{C} \\ \text{D} \end{array} \begin{array}{c} \begin{array}{cccc} \text{A} & \text{B} & \text{C} & \text{D} \end{array} \\ \begin{bmatrix} 3 & 1 & 2 & 1 \\ 1 & 2 & 1 & 2 \\ 2 & 1 & 3 & 1 \\ 1 & 2 & 1 & 2 \end{bmatrix} \end{array}$$

Marker Note(s):

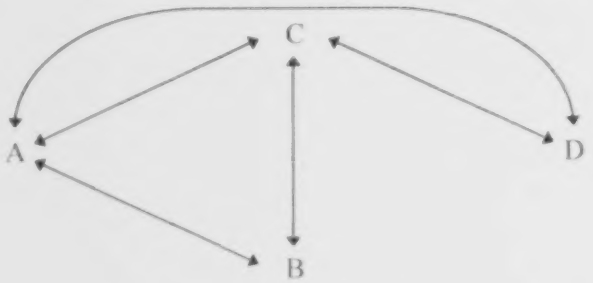
- *Maximum 0.5 mark deduction for each kind of technical communication error (incorrect use of brackets on matrices, or not expressing transition matrices as decimals or percentages).*
- *No mark deduction for matrix calculations or matrix errors in b) (no matrix is required).*

Marking Key
1 mark for correct answer in a) *1 mark for correct explanation in b)* *1 mark for correct answer in b)*

Exemplar 1

8. The following diagram represents the routes that a person can use to drive between the towns labelled A, B, C and D.

Total: 3 marks



a) Create a matrix M which corresponds to the network above.

(1 mark)

$$M = \begin{array}{c} \\ A \\ B \\ C \\ D \end{array} \begin{array}{c} \begin{array}{cccc} A & B & C & D \end{array} \\ \begin{bmatrix} 0 & 1 & 1 & 1 \\ 1 & 0 & 1 & 0 \\ 1 & 1 & 0 & 1 \\ 1 & 0 & 1 & 0 \end{bmatrix} \end{array}$$

b) A student was asked how to calculate the number of ways to travel between two towns going through exactly one other town. The student answered, "$M + M^2$". Explain their error and show the correct answer.

(2 marks)

M^2 because you are not going through one town and back

$$N = \begin{bmatrix} 3 & 1 & 2 & 1 \\ 1 & 2 & 1 & 2 \\ 2 & 1 & 3 & 1 \\ 1 & 2 & 1 & 2 \end{bmatrix}$$

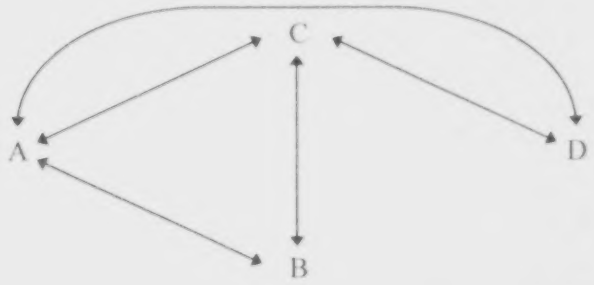
2 marks:

- 1 mark for correct answer in a)
- 1 mark for correct answer in b)

Exemplar 2

8. The following diagram represents the routes that a person can use to drive between the towns labelled A, B, C and D.

Total: 3 marks



a) Create a matrix M which corresponds to the network above.

(1 mark)

$$\begin{array}{c} \\ A \\ B \\ C \\ D \end{array}\begin{array}{c} \begin{array}{cccc} A & B & C & D \end{array} \\ \begin{bmatrix} 0 & 0 & 1 & 1 \\ 1 & 0 & 1 & 0 \\ 1 & 1 & 0 & 1 \\ 1 & 0 & 1 & 0 \end{bmatrix} \end{array}$$

b) A student was asked how to calculate the number of ways to travel between two towns going through exactly one other town. The student answered, "$M + M^2$". Explain their error and show the correct answer.

(2 marks)

If you did $m+m^2$ it would result in: $\begin{bmatrix} 3 & 2 & 3 & 2 \\ 2 & 2 & 2 & 2 \\ 3 & 2 & 3 & 2 \\ 2 & 2 & 2 & 2 \end{bmatrix}$

when still there is no way for A to get back to A.

1 mark:

- 1 mark for correct answer in a) based on a maximum of one trivial error

Question No. 9 and Answer

9. A paddle wheel boat operator charges the following rates for a two-hour trip: adults—$12.50, students—$8.50 and children under 6 years of age—$2.50. The number of each type of ticket that was sold during the weekend is given in the following matrix:

Total: 2 marks

$$\begin{array}{l} \\ \text{Adults} \\ \text{Students} \\ \text{Children} \end{array} \begin{array}{c} \begin{array}{cc} \text{Saturday} & \text{Sunday} \end{array} \\ \begin{bmatrix} 108 & 75 \\ 84 & 122 \\ 53 & 72 \end{bmatrix} \end{array}$$

Determine the boat operator's revenue for each day. Show your work using the appropriate matrix operations.

$$\begin{array}{c} \begin{array}{ccc} \text{A} & \text{S} & \text{C} \end{array} \\ \begin{bmatrix} 12.50 & 8.50 & 2.50 \end{bmatrix} \end{array} \times \begin{bmatrix} 108 & 75 \\ 84 & 122 \\ 53 & 72 \end{bmatrix} = \begin{array}{c} \begin{array}{cc} \text{Saturday} & \text{Sunday} \end{array} \\ \begin{bmatrix} 2196.50 & 2154.50 \end{bmatrix} \end{array}$$

Marker Note(s):

- *Maximum 0.5 mark deduction for each kind of technical communication error (incorrect use of brackets on matrices, or not expressing transition matrices as decimals or percentages).*

Marking Key
1 mark for appropriate work shown indicating use of matrix operations *1 mark for correct answer*

Question No. 10 and Answer

10. Each year at Manitoba High School, the teachers sit on a committee.

Total: 4 marks

Currently:

- **30% are on the Sports committee**
- **20% are on the Arts committee**
- **50% are on the Graduation committee**

At the end of the school year, the teachers can change committees.
Here are the changes that took place last June:

- **10% of the teachers from each committee stayed on their committee**
- **15% of the members on the Sports committee joined the Graduation committee**
- **5% of the members on the Arts committee joined the Sports committee**
- **30% of the members of the Graduation committee joined the Arts committee**

a) Create a transition matrix which shows the changes in committees.

(2 marks)

$$T = \text{(From)}\begin{matrix} \\ S \\ A \\ G \end{matrix}\begin{matrix} \text{(To)} \\ S \\ \begin{bmatrix} 0.10 & 0.75 & 0.15 \\ 0.05 & 0.10 & 0.85 \\ 0.60 & 0.30 & 0.10 \end{bmatrix} \end{matrix}\begin{matrix} \\ \\ A \quad G \\ \\ \end{matrix}$$

b) If this trend continues, determine the percentage of teachers on each committee once it stabilizes. Provide proof of stabilization.

(2 marks)

If this trend continues, the committees will stabilize in the following manner:

$$P = \begin{matrix} S & A & G \end{matrix}\begin{bmatrix} 0.30 & 0.20 & 0.50 \end{bmatrix}$$

$$P \times T^{99} = P \times T^{100} = \begin{matrix} S & A & G \end{matrix}\begin{bmatrix} 0.27 & 0.35 & 0.38 \end{bmatrix} \quad \textbf{\textit{OR}} \quad 27\% \quad 35\% \quad 38\%$$

Marker Note(s):

- *Maximum 0.5 mark deduction for each kind of technical communication error (incorrect use of brackets on matrices, or not expressing transition matrices as decimals or percentages).*

Marking Key
1 mark for correct complements in a)
1 mark for correct rest of the matrix in a)
1 mark for showing the same stabilization point for 2 time periods in b)
1 mark for correct answer in b)

10. Each year at Manitoba High School, the teachers sit on a committee.

Total: 4 marks

Currently:

- 30% are on the Sports committee
- 20% are on the Arts committee
- 50% are on the Graduation committee

At the end of the school year, the teachers can change committees.
Here are the changes that took place last June:

- 10% of the teachers from each committee stayed on their committee
- 15% of the members on the Sports committee joined the Graduation committee
- 5% of the members on the Arts committee joined the Sports committee
- 30% of the members of the Graduation committee joined the Arts committee

a) Create a transition matrix which shows the changes in committees.

(2 marks)

$$T = \text{(From)} \begin{matrix} \\ \text{S} \\ \text{A} \\ \text{G} \end{matrix} \begin{matrix} \text{(To)} \\ \text{S} \quad \text{A} \quad \text{G} \end{matrix} \begin{bmatrix} 0.10 & 0.75 & 0.15 \\ 0.05 & 0.10 & 0.85 \\ 0.60 & 0.30 & 0.10 \end{bmatrix}$$

b) If this trend continues, determine the percentage of teachers on each committee once it stabilizes. Provide proof of stabilization.

(2 marks)

2nd matrix → enter data

(A)·(A) 50 years

$$50 \text{ years} = \begin{matrix} \text{S} & \text{A} & \text{G} \end{matrix} \begin{bmatrix} 0.27106 & 0.351648 & 0.37728 \end{bmatrix}$$

After 50 years it will stabilize.

3 marks:

- 1 mark for correct complements in a)
- 1 mark for correct rest of the matrix in a)
- 1 mark for correct answer in b)

Specific Outcomes: B1, B2 **Item Type: Open Response**

Question No. 11 and Answer

11. Marina and Phillip are pulling on a rock with equal force. They are at an angle of 40° to each other.

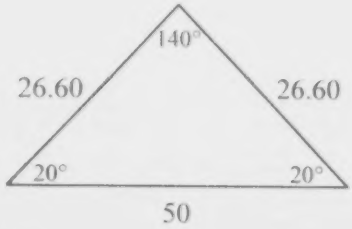
Total: 4 marks

a) If the resultant vector has a force of 50 newtons, determine the magnitude of the force with which each is pulling. Show your work.

(2 marks)

Trisolve:

Input:	Output:
$A = 50$	$AA = 140$
$AB = 20$	$B = 26.60$
$AC = 20$	$C = 26.60$

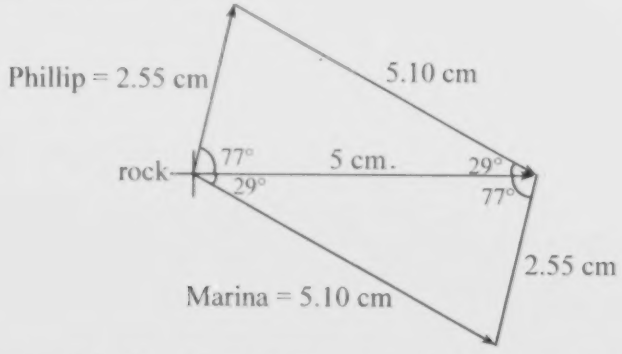


Each would pull with a force of 26.60 newtons.

b) If the resultant force remains at 50 newtons, at what angle could Marina and Phillip pull in order for Marina to pull with double the force of Phillip? Show your work.

(2 marks)

e.g., scale: 1 cm = 10 newtons



Marina pulls with a force of 51 newtons and Phillip pulls with a force of 25.50 newtons. The angle between them is (77° + 29°) 106°.

Other possible solutions range from:

Phillip pulls with a force of 17 newtons and Marina pulls with a force of 34 newtons. The angle they must pull in is $180° - 155.87° = 24.13°$.

to:

Phillip pulls with a force of 50 newtons and Marina pulls with a force of 100 newtons. The angle they must pull in is 180°.

Question No. 11 continued

Scoring Rubric

<table>
<tr><th colspan="2">General Performance Indicators</th></tr>
<tr><td colspan="2">Level 1—limited understanding</td></tr>
<tr><td colspan="2">1 mark
weak attempt: inappropriate strategy or no strategy
1 criterion correct</td></tr>
<tr><td colspan="2">Level 2—good understanding</td></tr>
<tr><td>2 marks
reasonable attempt: appropriate strategy, minor errors and/or omissions
2 criteria correct</td><td>3 marks
complete and correct with minor errors
3 criteria correct</td></tr>
<tr><td colspan="2">Level 3—exceptional understanding</td></tr>
<tr><td colspan="2">4 marks
complete and correct
4 criteria correct</td></tr>
</table>

Marker Note(s):

- *Maximum 0.5 mark deduction for each kind of technical communication error (missing more than one arrow in a vector diagram or not stating a scale when using a scale diagram as a strategy).*

Marking Key
1 mark for appropriate work in a) *1 mark for correct magnitude in a)* *1 mark for appropriate work in b)* *1 mark for correct answer in b)*

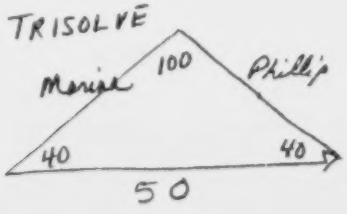
Exemplar 1

11. Marina and Phillip are pulling on a rock with equal force. They are at an angle of 40° to each other.

Total: 4 marks

a) If the resultant vector has a force of 50 newtons, determine the magnitude of the force with which each is pulling. Show your work.

(2 marks)

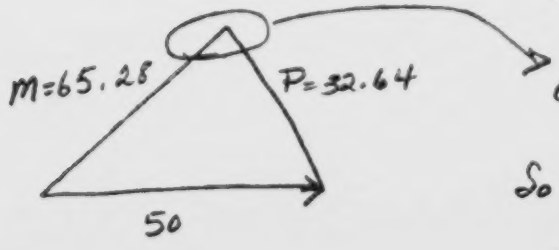


So $\vec{r} = 32.64N$

Marina and Phillip would each pull with a force of 32.64N

b) If the resultant force remains at 50 newtons, at what angle could Marina and Phillip pull in order for Marina to pull with double the force of Phillip? Show your work.

(2 marks)



$\theta = 48.44°$

So $180 - 48.44° = 131.56°$

The angle between Marina and Phillip should be $131.56°$

3 marks:

- 1 mark for appropriate work in a)
- 1 mark for appropriate work in b)
- 1 mark for correct answer in b)

Exemplar 2

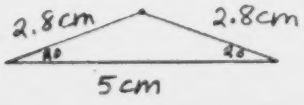
11. Marina and Phillip are pulling on a rock with equal force. They are at an angle of 40° to each other.

Total: 4 marks

a) If the resultant vector has a force of 50 newtons, determine the magnitude of the force with which each is pulling. Show your work.

(2 marks)

Scale = 1 cm = 10N

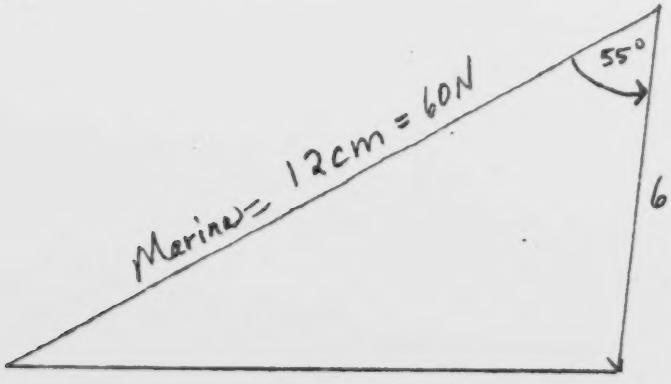


So Marina and Phillip would pull with a force of 10(2.8) = 28 N each

b) If the resultant force remains at 50 newtons, at what angle could Marina and Phillip pull in order for Marina to pull with double the force of Phillip? Show your work.

(2 marks)

Scale = 1 cm = 5N



So there will be an angle of 55° between Marina and Phillip

2.5 marks:

- 1 mark for appropriate work in a)
- 1 mark for correct magnitude in a)
- 1 mark for appropriate work in b)
- –0.5 mark for missing arrow in vector diagram

Specific Outcomes: B1, B2, B3 **Item Type: Restricted Response with Explanation**

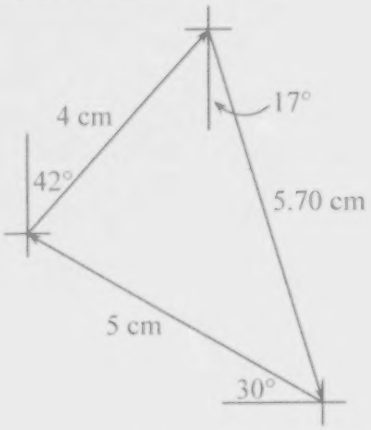
Question No. 12 and Answer

12. An airplane travels at a speed of 250 km/h in a direction of 30° north of west for one hour. It then travels at a speed of 300 km/h for 40 minutes in a direction of 42° east of north.

To return directly to its starting point, in what direction and what distance must the airplane travel? Show your work.

Total: 4 marks

1 cm = 50 km



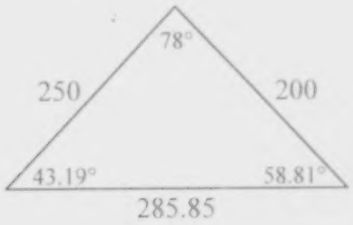
1 cm = 50 km ∴ 5.70 cm = 285 km

The airplane travels 285 km in a direction of 17° east of south.

OR

Trisolve:

Input:	Output:
$B = 200$	$A = 285.85$
$C = 250$	$AB = 43.19$
$AA = 78$	$AC = 58.81$



The plane travels 285.85 km in a direction of 16.81° east of south.

Marker Note(s):

- *Maximum 0.5 mark deduction for each kind of technical communication error (when using a scale diagram as a strategy, missing more than one arrow in a vector diagram or not stating a scale).*

Marking Key
1 mark for appropriate work
1 mark for conversion of distance
1 mark for correct magnitude
1 mark for correct direction

Exemplar 1

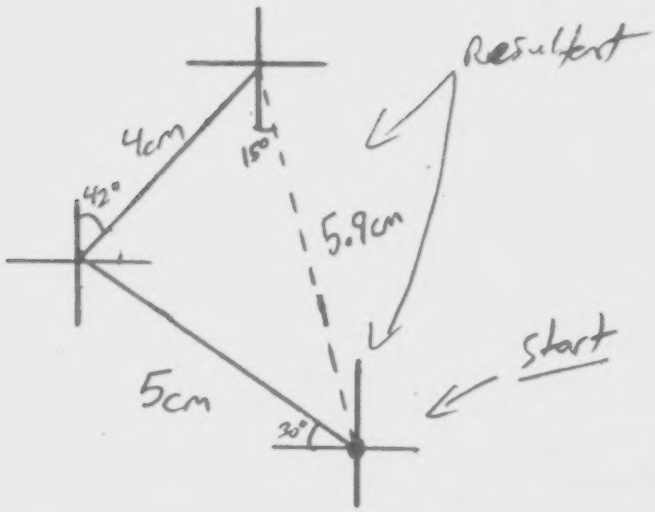
12. An airplane travels at a speed of 250 km/h in a direction of 30° north of west for one hour. It then travels at a speed of 300 km/h for 40 minutes in a direction of 42° east of north.

To return directly to its starting point, in what direction and what distance must the airplane travel? Show your work.

Total: 4 marks

1cm = 50 km

250 X 1 = 250 ÷ 50 = 5cm
300 X (2/3) = 200 ÷ 50 = 4cm



The aircraft must travel (5.9 x 50) 295 km at a heading of 15° W of N.

2.5 marks:

- 1 mark for appropriate work
- 1 mark for conversion of distance
- 1 mark for correct magnitude
- –0.5 mark for missing more than one arrow in vector diagram

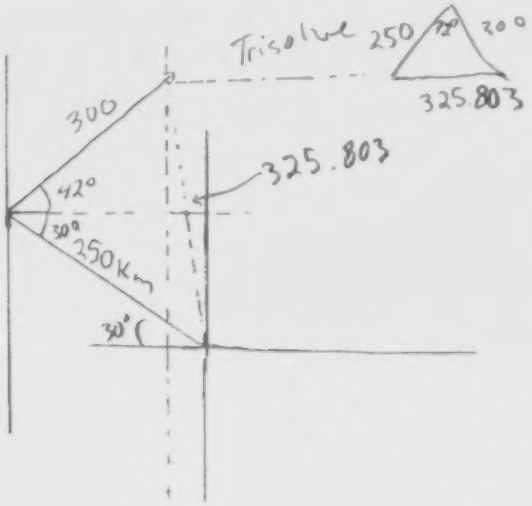
Exemplar 2

12. An airplane travels at a speed of 250 km/h in a direction of 30° north of west for one hour. It then travels at a speed of 300 km/h for 40 minutes in a direction of 42° east of north.

$300 \times \frac{2}{3} = 200$

To return directly to its starting point, in what direction and what distance must the airplane travel? Show your work.

Total: 4 marks



325.8 km/h

2 marks:

- 1 mark for appropriate work
- 1 mark for conversion of distance

Specific Outcome: C1 **Item Type: Restricted Response**

Question No. 13 and Answer

13. Derek is considering a $7500.00 loan amortized over 5 years at an interest rate of 6.50%, compounded monthly.

Total: 3 marks

a) What will his monthly payment be?

(1 mark)

TVM solver:

N =	60
I% =	6.50
PV =	7500
PMT =	−146.75
FV =	0
P/Y =	12
C/Y =	12
PMT =	END

OR

N =	60
I% =	6.50
PV =	7500
PMT =	-145.96
FV =	0
P/Y =	12
C/Y =	12
PMT =	BEGIN

b) How much interest will he pay in total over the 5 years? Show your work.

(2 marks)

$\$146.75 \times 60 = \$8805.00$

$\$8805.00 - \$7500.00 = \$1305.00$

OR

$\sum \text{int}(1, 60) = \$1304.77$

OR

$\$145.96 \times 60 = \$8757.60$

$\$8757.60 - \$7500.00 = \$1257.60$

OR

$\sum \text{int}(1, 60) = \$1257.33$

Marking Key
1 mark for correct answer in a) *1 mark for appropriate work in b)* *1 mark for correct answer in b)*

Question No. 14 and Answer

14. The Smith family can purchase a house valued at $100 000.00 with a down payment of $10 000.00, or they could rent a similar house.

Total: 5 marks

a) The monthly payment for a mortgage, amortized over 15 years at an interest rate of 6.50% compounded monthly, is $784.00. If the Smiths purchase the house, calculate the total amount paid, including the down payment, by the end of the first 5 years.

(1 mark)

$\$784.00 \times 60 + \$10\,000.00 = \$57\,040.00$

The total amount paid by the end of 5 years is $57 040.00.

b) Real estate appreciates at a rate of 3% per year. Determine the equity in the purchased house after 5 years. Show your work.

(3 marks)

Final value:

TVM solver:

N =	5
I% =	3
PV =	100 000
PMT =	0
FV =	**–115 927.41**
P/Y =	1
C/Y =	1
PMT =	END *OR* BEGIN

OR

$100\,000 \times 1.03^5 = \$115\,927.41$

OR

Time (years)	Value of the house ($)
0	100 000.00
1	103 000.00
2	106 090.00
3	109 272.70
4	112 550.88
5	**115 927.41**

Time (years)	Value of the house ($)
0	100 000.00
=A2+1	=B2*1.03
=A3+1	=B3*1.03
=A4+1	=B4*1.03
=A5+1	=B5*1.03
=A6+1	=B6*1.03

Question No. 14 continued

Amount left to pay on mortgage:

TVM solver:

N =	60
I% =	6.50
PV =	90 000
PMT =	–784.00
FV =	**–69 045.17**
P/Y =	12
C/Y =	12
PMT =	END

OR

TVM solver:

N =	60
I% =	6.50
PV =	90 000
PMT =	–784.00
FV =	**–68 745.04**
P/Y =	12
C/Y =	12
PMT =	BEGIN

OR

Months	Payment	Interest	Mortgage	Balance
0	784		90 000.00	10 000.00
1	784	487.50	89 703.50	10 296.50
2	784	485.89	89 405.39	10 594.61
3	784	484.28	89 105.67	10 894.33
4	784	482.66	88 804.33	11 195.67
5	784	481.02	88 501.35	11 498.65
⋮	⋮	⋮	⋮	⋮
59	784	378.40	69 452.97	30 547.03
60	**784**	**376.20**	**69 045.17**	**30 954.83**

Months	Payment	Interest	Mortgage	Balance
0	784		90 000.00	10 000.00
=A2+1	784	=D2*0.065/12	=D2-(B3-C3)	=E2+(B3-C3)
=A3+1	784	=D3*0.065/12	=D3-(B4-C4)	=E3+(B4-C4)
=A4+1	784	=D4*0.065/12	=D4-(B5-C5)	=E4+(B5-C5)
=A5+1	784	=D5*0.065/12	=D5-(B6-C6)	=E5+(B6-C6)
=A6+1	784	=D6*0.065/12	=D6-(B7-C7)	=E6+(B7-C7)
⋮	⋮	⋮	⋮	⋮
=A60+1	784	=D60*0.065/12	=D60-(B61-C61)	=E60+(B61-C61)
=A61+1	**784**	**=D61*0.065/12**	**=D61-(B62-C62)**	**=E61+(B62-C62)**

Question No. 14 continued

Equity:

115 927.41 (final value)
– 69 045.17 (amount left to pay on mortgage)
$46 882.24 (equity in the house after 5 years)

OR

115 927.41 (final value)
– 68 745.04 (amount left to pay on mortgage)
$47 182.37 (equity in the house after 5 years)

OR

Equity in the house after 5 years =
final value ($115 927.41) – amount left to pay on mortgage ($69 045.17) = $46 882.24

c) Given that it is more expensive to rent, give one reason why the Smiths would choose to rent.

(1 mark)

If the Smiths rent the house:
- they would not worry about the changing real estate market;
- they would have $10 000.00 available for investing;
- they would have no maintenance costs; and
- they would have easier access to their money.

Other answers are possible.

Question No. 14 continued

Scoring Rubric

General Performance Indicators	
Level 1—limited understanding	
1 mark **weak attempt: inappropriate strategy or no strategy** 1 criterion correct	**2 marks** **reasonable attempt: appropriate strategy with major errors or omissions** 2 criteria correct
Level 2—good understanding	
3 marks **reasonable strategy, minor errors and/or omissions** 3 criteria correct	**4 marks** **sound strategy, mostly complete, minor errors** 4 criteria correct
Level 3—exceptional understanding	
5 marks **complete and correct** 5 criteria correct	

Marking Key
1 mark for correct total amount in a) *1 mark for house appreciation in b)* *1 mark for amount left owing in b)* *1 mark for equity in b)* *1 mark for reason in c)*

Exemplar 1

14. The Smith family can purchase a house valued at $100 000.00 with a down payment of $10 000.00, or they could rent a similar house.

Total: 5 marks

a) The monthly payment for a mortgage, amortized over 15 years at an interest rate of 6.50% compounded monthly, is $784.00. If the Smiths purchase the house, calculate the total amount paid, including the down payment, by the end of the first 5 years.

(1 mark)

$784 \times 5 = 3920 + 10000 =$ $13920

b) Real estate appreciates at a rate of 3% per year. Determine the equity in the purchased house after 5 years. Show your work.

(3 marks)

N = 5
I% = 6.50
PV = 90000
PMT = -784
FV = -88501.35
P/y = 12
C/y = 12
PMT: END

Appreciates
$100000 \times 1.03^5 = 115927.41$

equity is $115927.41 - 88501.35$
$= \$27426.06$

c) Given that it is more expensive to rent, give one reason why the Smiths would choose to rent.

(1 mark)

They're planning on moving in a year and don't want to have to sell a house.

3 marks:
- 1 mark for house appreciation in b)
- 1 mark for equity in b)
- 1 mark for reason in c)

Specific Outcomes: D2, D3 **Item Type: Restricted Response**

Question No. 15 and Answer

15. A ship is equipped with 6 flags which are identical except in colour. Of the 6 flags, 3 are red, 2 are blue and 1 is green. Depending on the order of the colour and the number of flags flown, different signals can be sent.

Total: 3 marks

a) Using all 6 flags, how many different signals can be sent?

(1 mark)

$$\frac{6!}{3!2!} = 60$$

b) Using only 3 flags, create a sample space showing the different signals that can be made if at least 2 of the flags must be red. State the number of different signals.

(2 marks)

RRR		
RRB	RBR	BRR
RRG	RGR	GRR

Seven different signals can be made.

Marking Key
1 mark for correct answer in a)
1 mark for correct sample space in b)
1 mark for answer based on sample space in b)

Question No. 16 and Answer

16. A group of 480 students at the Manitoba Collegiate Institute are classified by year and mathematics course taken. The following chart shows the result of this classification:

Total: 3 marks

	Consumer Mathematics	Applied Mathematics	Pre-Calculus Mathematics
Senior 2	50	60	40
Senior 3	60	70	30
Senior 4	70	70	30

a) What is the probability that a randomly selected student is taking a Consumer Mathematics course?

(1 mark)

$$\frac{\text{All Consumer Mathematics students}}{\text{All Mathematics course students}} = \frac{180}{480} = 0.38$$

b) Consider only Senior 3 and Senior 4 students. What is the probability that a randomly selected student is taking an Applied Mathematics or Pre-Calculus Mathematics course? Show your work.

(2 marks)

$$\frac{\text{S3 and S4 Applied Mathematics or Pre-Calculus Mathematics students}}{\text{All S3 and S4 Mathematics students}} = \frac{200}{330} = 0.61$$

OR

$$P(\text{A}) \text{ or } P(\text{PC}) = \frac{140}{330} + \frac{60}{330} = \frac{200}{330} = 0.61$$

Marking Key
1 mark for correct answer in a) *1 mark for a numerator of 200 in b)* *1 mark for correct answer in b)*

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Question No. 17 and Answer

17. The marks for a first year biology course at Zenith University are normally distributed. The professors decided to award final grades using the following system:

Total: 5 marks

- **the top 5% of the students will receive an A**
- **the next 15% of the students will receive a B**
- **60% of the students will receive a C**
- **15% of the students will receive a D**
- **5% of the students will receive an F**

Brigitte has a final grade of 77% in the course. The mean is 64% and the standard deviation is 7%.

a) What is Brigitte's *z*-score?

(1 mark)

$$\text{Brigitte's } z\text{-score: } \frac{77 - 64}{7} = 1.86$$

b) Find the letter grade that Brigitte will get in the course. Show your work.

(2 marks)

$$\text{normalcdf}(77, 100, 64, 7) = 0.03$$

OR

$$\text{normalcdf}(1.86, E99) = 0.03$$

OR

$$1 - \text{normalcdf}(0, 77, 64, 7) = 1 - 0.97 = 0.03$$

OR

$$\text{shadenorm}(1.86, 5) = 0.03$$

OR

The percentage of grades greater than Brigitte's is 3.14%, based on a *z*-score of 1.86 and an area of 0.9686 on the normal distribution table.

OR

Question No. 17 continued

Normal Distribution Probabilities	
Score 1	77
Score 2	
Mean	64
Standard Deviation	7
P (< Score 1)	0.978 4
P (> Score 1)	0.031 6
P (< Score 2)	0
P (> Score 2)	1
P (> Score 1, < Score 2)	–0.97

The percentage of grades greater than Brigitte is 3.16%.

AND

Brigitte would get an A.

c) With a minimum of a B letter grade, Robert will maintain his basketball scholarship. What is the minimum grade, as a percent, that Robert must obtain in the biology course to earn a B? Show your work.

(2 marks)

$$\text{invNorm}(0.80, 64, 7) = 69.89\%$$

Robert needs a minimum of 69.89% to obtain a B.

Marking Key
1 mark for correct answer in a)
1 mark for appropriate work in b)
1 mark for correct letter grade in b)
1 mark for appropriate work in c)
1 mark for correct answer in c)

Exemplar 1

17. The marks for a first year biology course at Zenith University are normally distributed. The professors decided to award final grades using the following system:

Total: 5 marks

- the top 5% of the students will receive an A
- the next 15% of the students will receive a B
- 60% of the students will receive a C
- 15% of the students will receive a D
- 5% of the students will receive an F

Brigitte has a final grade of 77% in the course. The mean is 64% and the standard deviation is 7%.

a) What is Brigitte's z-score?

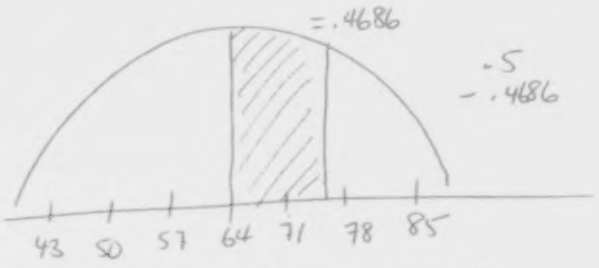
(1 mark)

$\frac{\mu - \bar{x}}{\sigma} = \frac{77-64}{7} = 1.86$

her z-score was 1.86

b) Find the letter grade that Brigitte will get in the course. Show your work.

(2 marks)



Brigitte would get a B
her z score is above average

c) With a minimum of a B letter grade, Robert will maintain his basketball scholarship. What is the minimum grade, as a percent, that Robert must obtain in the biology course to earn a B? Show your work.

(2 marks)

invNorm(.15, 64, 7) = 56.74

The minimum score would be 57%

3 marks:

- 1 mark for correct answer in a)
- 1 mark for appropriate work in b)
- 1 mark for appropriate work in c)

Exemplar 2

17. The marks for a first year biology course at Zenith University are normally distributed. The professors decided to award final grades using the following system:

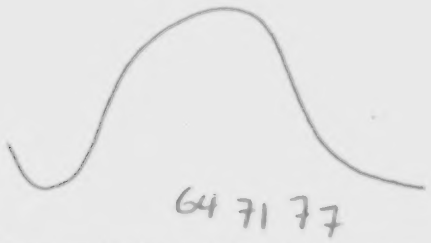
Total: 5 marks

- the top 5% of the students will receive an A
- the next 15% of the students will receive a B
- 60% of the students will receive a C
- 15% of the students will receive a D
- 5% of the students will receive an F

Brigitte has a final grade of 77% in the course. The mean is 64% and the standard deviation is 7%.

a) What is Brigitte's z-score?

(1 mark)



1.86

b) Find the letter grade that Brigitte will get in the course. Show your work.

(2 marks)

A = 5% of students get A's
she is in the top .041 of the class

c) With a minimum of a B letter grade, Robert will maintain his basketball scholarship. What is the minimum grade, as a percent, that Robert must obtain in the biology course to earn a B? Show your work.

(2 marks)

69.89%

3 marks:

- 1 mark for correct answer in a)
- 1 mark for correct letter grade in b)
- 1 mark for correct answer in c)

Question No. 18 and Answer

18. A research study on fruit flies found that an average of 50% of them stay alive after 32 hours.

Total: 3 marks

a) Determine the 95% confidence interval for the percentage of a sample of 1000 fruit flies still alive after 32 hours. Show your work.

(2 marks)

$$\overline{x} = np$$
$$= 1000 \times 0.50$$
$$= 500$$
$$\sigma = \sqrt{npq}$$
$$= \sqrt{1000 \times 0.50 \times 0.50}$$
$$= 15.81$$

$$\text{minimum} = 500 - 1.96 \times 15.81 = 469$$
$$\text{maximum} = 500 + 1.96 \times 15.81 = 531$$
$$46.90\% \text{ to } 53.10\%$$

OR

1 – Prop Z Int
$x = 500$
$n = 1000$
C-level = 95
Calculate
$(0.469, 0.531) \times 1000 = 46.90\%$ to 53.10%

OR

Confidence Interval	
Mean	500
Standard Deviation,	15.81
Number of Scores	1000
Confidence Level	95
Smallest Value	469.01
Largest Value	530.99
Smallest Proportion Value	0.469 01
Largest Proportion Value	0.530 99

$= 46.90\%$ to 53.10%

Question No. 18 continued

b) Explain the meaning of the confidence interval in a).

(1 mark)

You can be 95% certain that from 46.90% to 53.10%
of fruit flies will still be alive after 32 hours.

Marking Key
1 mark for appropriate work in a) *1 mark for correct answer in a)* *1 mark for correct explanation in b)*

Exemplar 1

18. A research study on fruit flies found that an average of 50% of them stay alive after 32 hours.

Total: 3 marks

a) Determine the 95% confidence interval for the percentage of a sample of 1000 fruit flies still alive after 32 hours. Show your work.

(2 marks)

$n = 1000$

$p = 50$

$\mu = np \rightarrow 1000(.5) = 500$

C-level = .95

$X = 500$

$n = 1000$

C-level = .95

(.46901, .53099)

$p = .5$

$n = 1000$

b) Explain the meaning of the confidence interval in a).

(1 mark)

95% confident that 469-531 flies will be left

3 marks:

- 1 mark for appropriate work in a)
- 1 mark for correct answer in a)
- 1 mark for correct explanation in b)

Exemplar 2

18. A research study on fruit flies found that an average of 50% of them stay alive after 32 hours.

Total: 3 marks

a) Determine the 95% confidence interval for the percentage of a sample of 1000 fruit flies still alive after 32 hours. Show your work.

(2 marks)

$\mu = 1000 \times .50$

$= 500$

$\sigma = \sqrt{n \times p \times (1-p)}$

15.81

Confidence interval

$\mu \pm 1.96\sigma$

$\mu - 1.96\sigma$: $500 - 30.99 = 469.01$

$\mu + 1.96\sigma$: $500 + 30.99 = 530.99$

b) Explain the meaning of the confidence interval in a).

(1 mark)

How sure we are that 50% will survive.

1 mark:

- 1 mark for appropriate work in a)

Question No. 19 and Answer

19. **The following data represents the sunrise times in Brandon, Manitoba on the first day of each month during the year 2003. Sunrise times are expressed in hours after midnight.**

Total: 4 marks

Month/Day	Day of year	Sunrise time (hours)
January 1	1	8.62
February 1	32	8.20
March 1	60	7.38
April 1	91	6.27
May 1	121	5.90
June 1	152	5.60
July 1	182	5.58
August 1	213	6.15
September 1	244	6.92
October 1	274	7.65
November 1	305	7.98
December 1	335	8.25

a) **Determine the equation of the sinusoidal curve of best fit for this data.**

(2 marks)

$$y = 1.45\sin(0.02x + 1.74) + 6.94$$

OR

$$y = 1.45\cos(0.02x + 0.17) + 6.94$$

b) **According to your equation, what is the median sunrise time for the year 2003?**

(1 mark)

6.94 hours ***OR*** 6:56 a.m. or 6:57 a.m.

Question No. 19 continued

c) What does one complete cycle represent?

(1 mark)

One complete cycle represents a complete year of sunrise times for Brandon, Manitoba.

OR

$$\frac{2\pi}{0.02} = 314 \text{ days}$$

Marker Note(s):

- *If "y =" is missing from an equation, deduct 0.5 mark.*

Marking Key
2 marks for correct equation (0.5 mark for each parameter: a, b, c, d) in a) *1 mark for correct answer in b)* *1 mark for correct answer in c)*

Question No. 20 and Answer

20. **A stone has become stuck in Justin's bicycle tire. The following equation describes the height of the stone, as compared to the ground, as the tire rotates.**

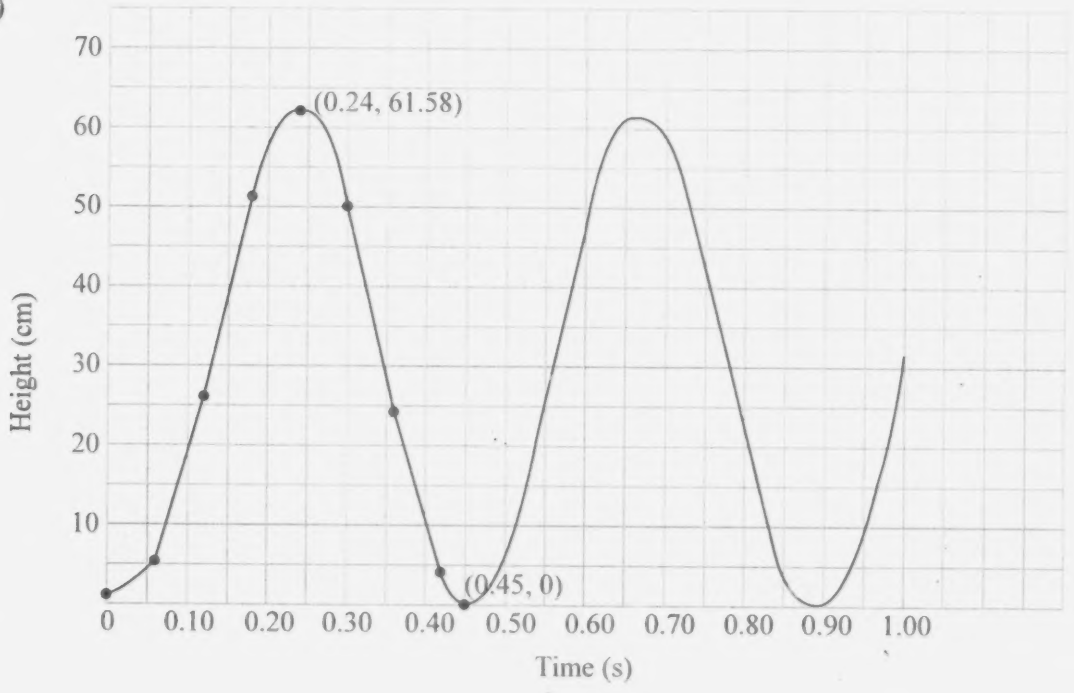
Total: 3 marks

$$h = 30.79\sin(14.47t - 1.87) + 30.79$$

where t represents time in seconds
and h represents the height of the stone above the ground in centimetres.

a) Sketch a graph which represents the height of the stone as a function of time. The graph must start at $t = 0$ and show one second. Label the maximum and minimum values of your graph.

(2 marks)



b) What will the height of the stone be at $t = 1.00$ second?

(1 mark)

31.83 cm

Marking Key
1 mark for correct maximum and minimum values labelled in a)
1 mark for correct curve for one second in a)
1 mark for correct answer in b)

Marking Keys and Scoring Rubrics for the Inquiry Task

Specific Outcomes: F1, F2, F4 | Item Type: Open Response

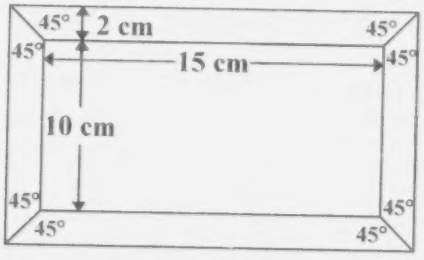
Inquiry Task Question No. 1 and Answer

DESIGN AND MEASUREMENT

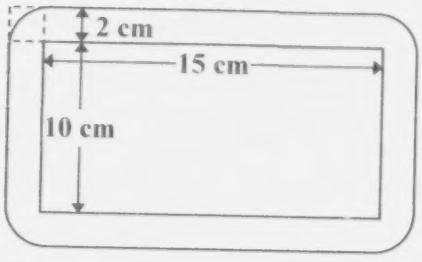
1. **The manager for a company that sells wooden picture frames asks you to prepare cost estimates and specific information for the construction of two models of frames. Model A is a rectangular frame with square corners and Model B is a rectangular frame with rounded corners. Both frames fit pictures that are 10 cm × 15 cm.**

Total: 10 marks

Model A



Model B



Here is the information that you will need:

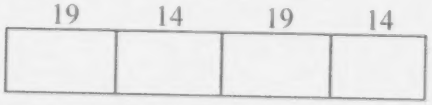
- **The wood is 2 cm wide.**
- **Corners are formed when two pieces of wood are joined which have been cut at a 45° angle.**
- **The glass which covers the photo must overlap it by 0.50 cm on each side in order to be positioned behind the frame.**

a) Determine the minimum length of wood and the minimum area of glass used for one Model A frame. Show how you determined the minimum length of the wood.

(3 marks)

Wood for Model A frame:

Top view with straight cuts:

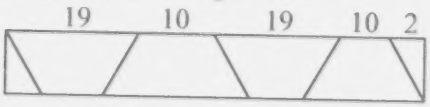


$L = 2(19) + 2(14)$

$= 66$ cm

OR

Top view with angle cuts:



$L = 19 + 10 + 19 + 10 + 2$

$= 60$ cm

Glass for Model A frame:

$A = (10 + 0.50 + 0.50) \times (15 + 0.50 + 0.50)$

$= 11 \text{ cm} \times 16 \text{ cm}$

$= 176 \text{ cm}^2$

Question No. 1 continued

b) The company also wants to sell a frame with rounded outside corners called Model B. Calculate the area of wood wasted on each frame to round these corners assuming the curve on each corner is a $\frac{1}{4}$ circle. Show your work.

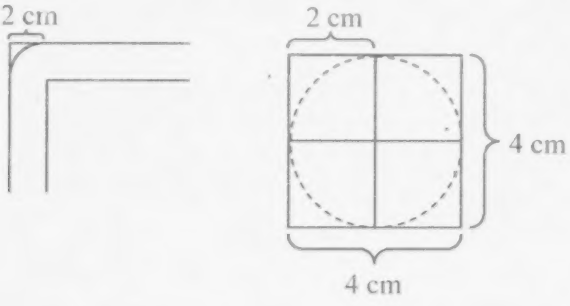
(2 marks)

Wood wasted for outside corners for Model B frame:

$A_{square} = l \times w$
$= 4 \times 4$
$= 16 \text{ cm}^2$

$A_{circle} = \pi r^2$
$= \pi(2)^2$
$= 12.57 \text{ cm}^2$

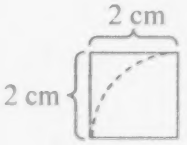
$A_{square} - A_{circle} = 16 \text{ cm}^2 - 12.57 \text{ cm}^2 = 3.43 \text{ cm}^2$ (wood cut off from corners)



OR

$A_{square} = l \times w$
$= 2 \times 2$
$= 4 \text{ cm}^2$

$A_{quarter\ circle} = \frac{\pi r^2}{4}$
$= \frac{\pi(2)^2}{4}$
$= 3.14 \text{ cm}^2$ (for 1 corner)

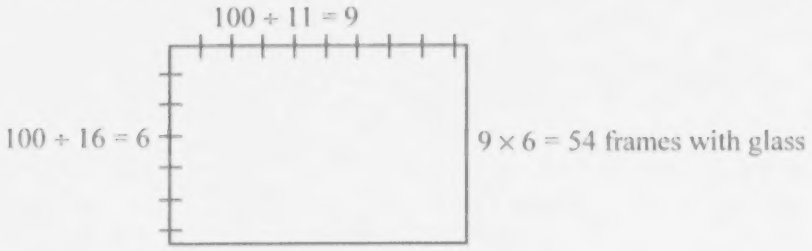


$A_{wood\ wasted} = 4 - 3.14 = 0.86 \text{ cm}^2$
$0.86 \text{ cm}^2 \times 4 \text{ corners} = 3.44 \text{ cm}^2$ (wood cut off from corners)

Question No. 1 continued

c) Glass is purchased in 1 m × 1 m sheets. Determine the maximum number of pieces of glass that can be cut for a Model A frame from a single sheet of glass.

(1 mark)



d) Calculate the total cost without taxes to construct the number of Model A frames found in part c) if:

- **The wood is purchased in 2 m strips which cost $7.35 per strip.**
- **Each side of the frame is made from a single piece of wood.**
- **Glass is sold for $14.00 per square metre (1 m × 1 m).**

Show your work.

(3 marks)

Total cost of wood for 54 frames:

with straight cuts:

200 ÷ 66 = 3 frames

54 ÷ 3 = 18 strips of wood needed

(18 × 7.35) + 14 = $146.30

OR

with angle cuts:

3 frames constructed from a 2 m strip with 24 cm left over

∴ 1 extra frame for every 3 strips of wood

10 frames constructed from 3 strips of wood

50 frames constructed from 15 strips of wood

so you will need 17 strips of wood to construct 54 frames

(17 × 7.35) + 14 = $138.95

e) Calculate the cost to construct each Model A frame. Do not include taxes.

(1 mark)

with straight cuts:

$146.30 ÷ 54 = $2.71

OR

with angle cuts:

$138.95 ÷ 54 = $2.57

Question No. 1 continued

Scoring Rubric

General Performance Indicators			
Level 1—limited understanding			
1 mark **weak attempt: inappropriate strategy or no strategy** 1 criterion correct	**2 marks** **reasonable attempt: inappropriate strategy, major errors or omissions** 2 criteria correct	**3 marks** **reasonable attempt: inappropriate strategy but carried through correctly** 3 criteria correct	
Level 2—good understanding			
4 marks **sound strategy with major errors** 4 criteria correct	**5 marks** **sound strategy with minor errors** 5 criteria correct	**6 marks** **mostly complete with some omissions** 6 criteria correct	**7 marks** **almost complete and correct, major errors** 7 criteria correct
Level 3—exceptional understanding			
8 marks **complete, two minor errors, trivial errors** 8 criteria correct	**9 marks** **complete, one minor error** 9 criteria correct	**10 marks** **complete and correct** 10 criteria correct	

Marker Note(s):

- *Do not deduct marks if student includes taxes in d) or e).*

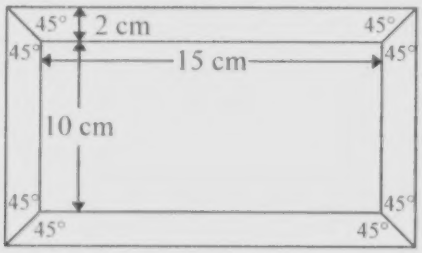
Marking Key
1 mark for appropriate work for length of wood in a)
1 mark for correct minimum length of wood in a)
1 mark for correct minimum area of glass in a)
1 mark for appropriate work in b)
1 mark for correct answer in b)
1 mark for correct maximum number of pieces of glass in c) consistent with area in a)
1 mark for appropriate work for length of wood in d)
1 mark for number of strips of wood in d) consistent with answers in a) and c)
1 mark for total cost in d)
1 mark for dividing by the number of frames in e) consistent with answer in d)

Exemplar 1

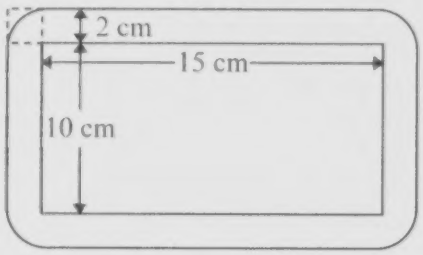
1. The manager for a company that sells wooden picture frames asks you to prepare cost estimates and specific information for the construction of two models of frames. **Model A** is a rectangular frame with square corners and **Model B** is a rectangular frame with rounded corners. Both frames fit pictures that are 10 cm × 15 cm.

Total: 10 marks

Model A



Model B



Here is the information that you will need:

- The wood is 2 cm wide.
- Corners are formed when two pieces of wood are joined which have been cut at a 45° angle.
- The glass which covers the photo must overlap it by 0.50 cm on each side in order to be positioned behind the frame.

a) Determine the minimum length of wood and the minimum area of glass used for one Model A frame. Show how you determined the minimum length of the wood.

(3 marks)

132.00 cm² of wood ((14×2)2)+((19×2)2)

176.00 cm² of glass (11×16)

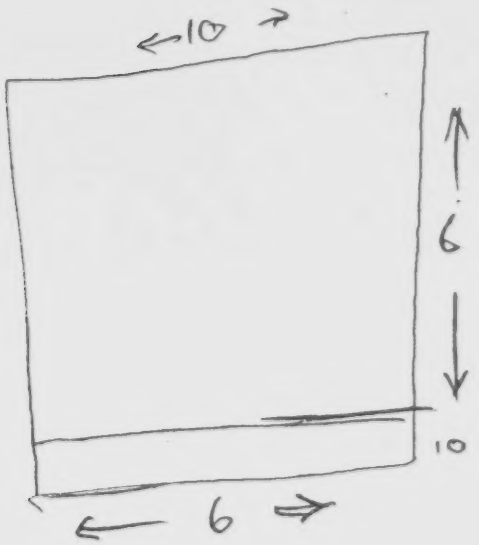
b) The company also wants to sell a frame with rounded outside corners called Model B. Calculate the area of wood wasted on each frame to round these corners assuming the curve on each corner is a $\frac{1}{4}$ circle. Show your work.

(2 marks)

$\frac{16\text{ cm} - 12.57}{4} = .86\text{ cm}^2$

c) Glass is purchased in 1 m × 1 m sheets. Determine the maximum number of pieces of glass that can be cut for a Model A frame from a single sheet of glass.

(1 mark)



66 sheets for the frames

d) Calculate the total cost without taxes to construct the number of Model A frames found in part c) if:

- The wood is purchased in 2 m strips which cost $7.35 per strip.
- Each side of the frame is made from a single piece of wood.
- Glass is sold for $14.00 per square metre (1 m × 1 m).

Show your work.

(3 marks)

62 cm wood per frame
$\times 66 = \frac{4092 \text{ cm}}{100} = 40.92 \text{ m} = \frac{41 \text{ m}}{2} =$ 21 m

21 strips $\times$ 7.35 = 154.35
+ 14.00
168.35 $\times$ .14 = 23.57
= 191.92 $

assuming tax = 14%

e) Calculate the cost to construct each Model A frame. Do not include taxes.

(1 mark)

$\frac{191.92}{66} = 2.91$

5 marks:

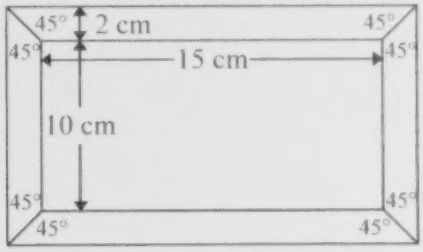
- 1 mark for appropriate work for length of wood in a)
- 1 mark for correct minimum area of glass in a)
- 1 mark for appropriate work in b)
- 1 mark for total cost in d)
- 1 mark for dividing by the number of frames in e) consistent with answer in d)

Exemplar 2

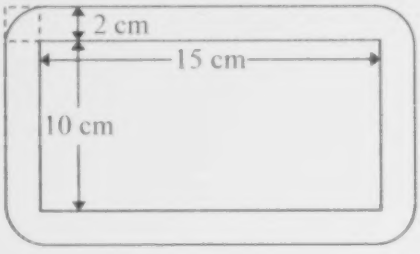
1. The manager for a company that sells wooden picture frames asks you to prepare cost estimates and specific information for the construction of two models of frames. **Model A** is a rectangular frame with square corners and **Model B** is a rectangular frame with rounded corners. Both frames fit pictures that are 10 cm × 15 cm.

Total: 10 marks

Model A



Model B



Here is the information that you will need:

- The wood is 2 cm wide.
- Corners are formed when two pieces of wood are joined which have been cut at a 45° angle.
- The glass which covers the photo must overlap it by 0.50 cm on each side in order to be positioned behind the frame.

a) Determine the minimum length of wood and the minimum area of glass used for one Model A frame. Show how you determined the minimum length of the wood.

(3 marks)

model A: $15 \times 2 = 30\text{cm}^2 \times 2 = 60\text{cm}^2$

$10 \times 2 = 20\text{cm}^2 \times 2 = 40\text{cm}^2$

100cm^2

or $10+10+15+15+2+2+2+2 = 58\text{cm}$ perimeter

$15+(0.5\times2) = 16\text{cm}$

$10+(0.5\times2) = 11\text{cm}$

$16\text{cm} \times 11\text{cm} = 165\text{cm}^2$

∴ they will need 100cm^2 of wood & 165cm^2 of glass for one model A frame

b) The company also wants to sell a frame with rounded outside corners called Model B. Calculate the area of wood wasted on each frame to round these corners assuming the curve on each corner is a $\frac{1}{4}$ circle. Show your work.

(2 marks)

$A_{circle} = \pi r^2$

sides are 2cm ∴ diameter of the circle would be 2cm ∴ radius = 1cm

$\pi 1^2 = 3.14/4$ (1/4 of circle)

0.79

$3.14 - 0.79 = 2.35$

∴ $2.35\ cm^2$ is wasted

c) Glass is purchased in 1 m × 1 m sheets. Determine the maximum number of pieces of glass that can be cut for a Model A frame from a single sheet of glass.

(1 mark)

1m = 100cm

$100 \times 100 = 10000\ cm^2$ of glass

$165\ cm^2$ per frame

$10000 / 165 = 60$

∴ 60 pieces of glass can be cut..

d) Calculate the total cost without taxes to construct the number of Model A frames found in part c) if:

- The wood is purchased in 2 m strips which cost $7.35 per strip.
- Each side of the frame is made from a single piece of wood.
- Glass is sold for $14.00 per square metre (1 m × 1 m).

Show your work.

(3 marks)

60 frames

2m = 200cm
15+15=30+8=38+20=58cm
165cm² glass 14.00 per 100x100 & 10000cm
10000/165 = 60.60 → $14.00 for glass
58cm wood x 60 = 3480cm total
3480cm / 200cm = 17.4 → 15 strips
Glass $14.00
7.35(15)
110.25
$117.6 x 1.14 = $134.06 to produce 60 frames

e) Calculate the cost to construct each Model A frame. Do not include taxes.

(1 mark)

$134.06 / 60 = $2.23 per frame

5 marks:

- 1 mark for appropriate work for length of wood in a)
- 1 mark for minimum area of glass based on trivial error in a)
- 1 mark for appropriate work in b)
- 1 mark for appropriate work for length of wood in d)
- 1 mark for dividing by the number of frames in e) consistent with answer in d)

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Specific Outcomes: H1, H3 | Item Type: Open Response

Inquiry Task Question No. 2 and Answer

SEQUENCES

2. **Jasmine broke her collarbone in a bicycle accident. Her doctor's prescription contains the following information:**

Total: 9 marks

- **Each pill contains 240 mg of medication.**
- **Jasmine must take two pills every 12 hours. This represents one dose.**
- **She must take all 32 pills as prescribed.**

a) If her kidneys eliminate 60% of the medication from her body every 12 hours, how much of the medication is in Jasmine's system immediately after she takes the 6th dose? Show your work.

(2 marks)

$n(\text{Min}) = 1$

$u(n) = u(n-1) \times 0.40 + 480$

$u(n\text{Min}) = 480$

$t_6 = 796.72$ mg

OR

$n(\text{Min}) = 0$

$u(n) = u(n-1) \times 0.40 + 480$

$u(n\text{Min}) = 480$

$t_5 = 796.72$ mg

OR

Doses	Medication (mg)
0	0
1	480.00
2	672.00
3	748.80
4	779.52
5	791.81
6	**796.72**

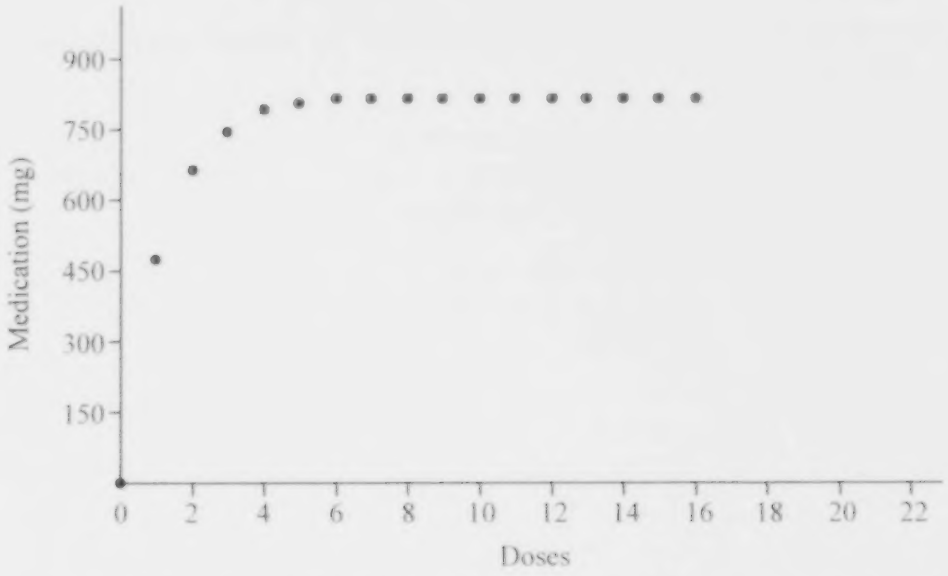
Doses	Medication (mg)
0	0
1	480.00
=A3+1	=B3*0.40+480
=A4+1	=B4*0.40+480
=A5+1	=B5*0.40+480
=A6+1	=B6*0.40+480
=A7+1	=B7*0.40+480

After the 6th dose there is 796.72 mg of medication in her system.

Question No. 2 continued

b) Sketch a graph that represents the sequence for 16 doses. Label the axes.

(2 marks)



c) At what level does the medication stabilize in Jasmine's body while she is taking her prescription?

(1 mark)

The level of medication stabilizes at 800 mg.

d) Assuming that Jasmine takes all her medication, how many hours would it take for her kidneys to eliminate the medication after her last dose? Note: The medication has been eliminated when its level in the blood is less than 1 mg. Show your work using data obtained from sequences.

(2 marks)

$$n(\text{Min}) = 0$$

$$u(n) = u(n-1) \times 0.40$$

$$u(n\text{Min}) \leq 800$$

$$t_{(7)} = 1.31$$

$$t_{(8)} = 0.52$$

$$8 \times 12 = 96 \text{ hours}$$

OR

Doses	Medication (mg)
15	800.00
16	800.00
Hours after last dose	
12	320.00
24	128.00
36	51.20
48	20.48
60	8.19
72	3.28
84	1.31
96	**0.52**

Doses	Medication (mg)
15	800.00
=A2+1	=B2*0.40+480
Hours after last dose	
12	=B3*0.40
=A5+12	=B5*0.40
=A6+12	=B6*0.40
=A7+12	=B7*0.40
=A8+12	=B8*0.40
=A9+12	=B9*0.40
=A10+12	=B10*0.40
=A11+12	=B11*0.40

c) **Jasmine visits another doctor for a second opinion before she begins taking any medication. The second doctor informs Jasmine that the quantity of medication in her body must be stabilized between 1000 mg and 1200 mg (inclusive) to eliminate the pain.**

Describe a schedule for taking the medication if the pill that Jasmine is prescribed contains 240 mg of medication. Her kidneys still eliminate 60% of the medication from her body every 12 hours. Show your work.

(2 marks)

$$n(\text{Min}) = 1$$
$$u(n) = u(n-1) \times 0.40 + 600$$
$$u(n\text{Min}) = 720$$

Jasmine starts with 3 pills and then takes 2.5 pills every 12 hours to stabilize the quantity of medication at 1000 mg.

OR

$$n(\text{Min}) = 1$$
$$u(n) = u(n-1) \times 0.40 + 720$$
$$u(n\text{Min}) = 480$$

Jasmine starts with 2 pills and then takes 3 pills every 12 hours to stabilize the quantity of medication at 1200 mg.

OR

Question No. 2 continued

Doses	Medication in her Body (mg)
0	0
1	480.00
2	912.00
3	1084.80
4	1153.92
5	1181.57
6	1192.63
⋮	⋮
15	1200.00
16	1200.00

Doses	Medication in her Body (mg)
0	0
=A2+1	480.00
=A3+1	=B3*0.40+720
=A4+1	=B4*0.40+720
=A5+1	=B5*0.40+720
=A6+1	=B6*0.40+720
=A7+1	=B7*0.40+720
⋮	⋮
=A16+1	=B16*0.40+720
=A17+1	=B17*0.40+720

Jasmine starts with 2 pills and then takes 3 pills every 12 hours to stabilize the quantity of medication at 1200 mg.

Other answers are possible.

Question No. 2 continued

Scoring Rubric

<table>
<tr><th colspan="4">General Performance Indicators</th></tr>
<tr><td colspan="4">Level 1—limited understanding</td></tr>
<tr><td>1 mark
weak attempt: inappropriate strategy or no strategy
1 criterion correct</td><td colspan="2">2 marks
reasonable attempt: inappropriate strategy, major errors or omissions
2 criteria correct</td><td>3 marks
reasonable attempt: inappropriate strategy but carried through correctly
3 criteria correct</td></tr>
<tr><td colspan="4">Level 2—good understanding</td></tr>
<tr><td>4 marks
sound strategy with major errors
4 criteria correct</td><td>5 marks
sound strategy with minor errors
5 criteria correct</td><td>6 marks
mostly complete with some omissions
6 criteria correct</td><td>7 marks
almost complete and correct, minor errors
7 criteria correct</td></tr>
<tr><td colspan="4">Level 3—exceptional understanding</td></tr>
<tr><td colspan="2">8 marks
complete, one minor error
8 criteria correct</td><td colspan="2">9 marks
complete and correct
9 criteria correct</td></tr>
</table>

Marker Note(s):

- *Answers including partial pills are accepted in e).*

Marking Key
1 mark for appropriate work in a) *1 mark for correct answer in a)* *1 mark for correct graph in b) consistent with work shown in a)* *1 mark for correct labels and x-axis at a minimum of 16 doses in b)* *1 mark for correct answer in c)* *1 mark for appropriate work in d)* *1 mark for correct answer in d)* *1 mark for description of medication schedule so that the quantity of medication stabilizes between 1000 mg and 1200 mg inclusive in e)* *1 mark for appropriate work in e)*

2. Jasmine broke her collarbone in a bicycle accident. Her doctor's prescription contains the following information:

Total: 9 marks

- Each pill contains 240 mg of medication.
- Jasmine must take two pills every 12 hours. This represents one dose.
- She must take all 32 pills as prescribed.

a) If her kidneys eliminate 60% of the medication from her body every 12 hours, how much of the medication is in Jasmine's system immediately after she takes the 6th dose? Show your work.

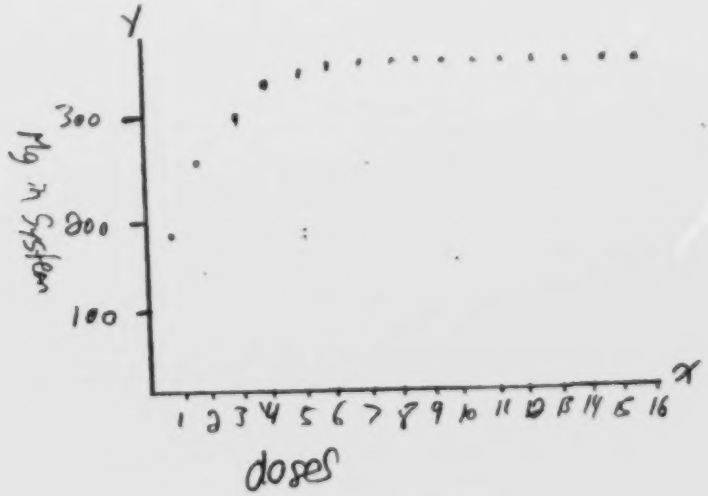
(2 marks)

① 480 x .6 = 288 480 - 288 = 192
② 192 + 480 = 672 x .6 = 403.2 672 - 403.2 = 268.8
③ 268.8 + 480 = 748.8 x .6 = 449.28 748.8 - 449.28 = 299.52
④ 299.52 + 480 = 779.52 x .6 = 467.712 779.52 - 467.712 = 311.808
⑤ 311.808 + 480 = 791.808 x .6 = 475.0848 791.808 - 475.0848 = 316.7232
⑥ 316.7232 + 480 = 796.7232 x .6 = 478.03392 796.7232 - 478.03392 = 318.68928

318 mg is in her system after 6 doses.

b) Sketch a graph that represents the sequence for 16 doses. Label the axes.

(2 marks)



c) At what level does the medication stabilize in Jasmine's body while she is taking her prescription?

(1 mark)

The medication stops increasing after the 15th dose.

d) Assuming that Jasmine takes all her medication, how many hours would it take for her kidneys to eliminate the medication after her last dose? Note: The medication has been eliminated when its level in the blood is less than 1 mg. Show your work using data obtained from sequences.

(2 marks)

319.21 × .6 = 191.526 319.21 − 191.526 = 127.684 × .6 =
76.6104 127.684 − 76.6104 = 51.0736 51.0736 × .6 =
30.64416 51.0736 − 30.64416 = 20.42944 × .6 = 12.26
20.43 − 12.26 = 8.17 × .6 = 4.902 8.17 − 4.9 = 3.27 × .6 = 1.96
3.27 − 1.96 = 1.31 × .6 = .786 1.31 − .786 = .524
It takes 3.5 days to wear it off to less than 1 mg

e) Jasmine visits another doctor for a second opinion before she begins taking any medication. The second doctor informs Jasmine that the quantity of medication in her body must be stabilized between 1000 mg and 1200 mg (inclusive) to eliminate the pain.

Describe a schedule for taking the medication if the pill that Jasmine is prescribed contains 240 mg of medication. Her kidneys still eliminate 60% of the medication from her body every 12 hours. Show your work.

(2 marks)

5 marks:

- 1 mark for appropriate work in a)
- 1 mark for correct answer in a)
- 1 mark for correct graph in b) consistent with work shown in a)
- 1 mark for correct labels and *x*-axis at a minimum of 16 doses in b)
- 1 mark for appropriate work in d)

Exemplar 2

2. Jasmine broke her collarbone in a bicycle accident. Her doctor's prescription contains the following information:

Total: 9 marks

- Each pill contains 240 mg of medication.
- Jasmine must take two pills every 12 hours. This represents one dose.
- She must take all 32 pills as prescribed.

a) If her kidneys eliminate 60% of the medication from her body every 12 hours, how much of the medication is in Jasmine's system immediately after she takes the 6th dose? Show your work.

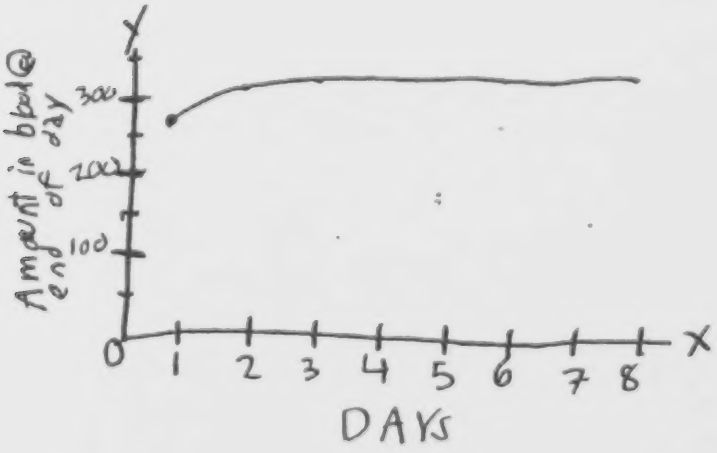
(2 marks)

hrs/dose	Amt in blood	Amnt after kidneys
6	240 mg	240 mg
12	480 mg	192 mg – 60% elim
18	432 mg	432 mg
24	672 mg	268.8 mg – 60% elim
30	508.8 mg	508.8 mg
36	748.8 mg	299.52 mg – 60% elim

299.52 mg remain after the 6th dose

b) Sketch a graph that represents the sequence for 16 doses. Label the axes.

(2 marks)



Day 1 - 268.8
2 - 311.81
3 - 318.69
4 - 319.79
5 - 319.99
6 - 319.99
7 - 320
8 - 320

c) At what level does the medication stabilize in Jasmine's body while she is taking her prescription?

(1 mark)

320 mg

d) Assuming that Jasmine takes all her medication, how many hours would it take for her kidneys to eliminate the medication after her last dose? Note: The medication has been eliminated when its level in the blood is less than 1 mg. Show your work using data obtained from sequences.

(2 marks)

e) Jasmine visits another doctor for a second opinion before she begins taking any medication. The second doctor informs Jasmine that the quantity of medication in her body must be stabilized between 1000 mg and 1200 mg (inclusive) to eliminate the pain.

Describe a schedule for taking the medication if the pill that Jasmine is prescribed contains 240 mg of medication. Her kidneys still eliminate 60% of the medication from her body every 12 hours. Show your work.

(2 marks)

4 marks:

- 1 mark for appropriate work in a)
- 1 mark for correct graph in b) consistent with work shown in a)
- 1 mark for correct labels and x-axis at a minimum of 16 doses in b)
- 1 mark for correct answer in c) consistent with work shown in b)

Appendices

APPENDIX A

Table of Specific Outcome Match and Item Type

Multiple-choice items				
Question No.	Key	Unit	Specific Outcome	Mark
1	C	A	1	1
2	D	B	1	1
3	B	C	4	1
4	A	C	4	1
5	A	D	2	1
6	C	E	2	1
7	B	G	1	1

Restricted-response items			
Question No.	Unit	Specific Outcome	Mark
9	A	2	2
10	A	2	4
13	C	1	3
15	D	2, 3	3
16	D	4	3
20	G	2, 3	3

Restricted-response with explanation items			
Question No.	Unit	Specific Outcome	Mark
8	A	1, 2	3
12	B	1, 2, 3	4
17	E	2	5
18	E	3	3
19	G	1, 2, 3	4

Open-response items			
Question No.	Unit	Specific Outcome	Mark
11	B	1, 2	4
14	C	1, 2	5
Inquiry 1	F	1, 2, 4	10
Inquiry 2	H	1, 3	9

APPENDIX B

Generating Student Profiles

Profile of Test Score by Question Type

Item Type	Test Items	Total	÷ Maximum	× 100	= %
Multiple-choice	1 to 7: ____		7		
Restricted-response	9 ____, 10 ____, 13 ____, 15 ____, 16 ____, 20 ____		18		
Restricted-response with explanation	8 ____, 12 ____, 17 ____, 18 ____, 19 ____		19		
Open-response	11 ____, 14 ____, Inquiry 1 ____, Inquiry 2 ____		28		

Profile of Test Score by Curriculum Unit

Unit	Test Items	Total	÷ Maximum	× 100	= %
Matrices	1 ____, 8 ____, 9 ____, 10 ____		10		
Vectors	2 ____, 11 ____, 12 ____		9		
Personal Finance	3 ____, 4 ____, 13 ____, 14 ____		10		
Probability	5 ____, 15 ____, 16 ____		7		
Variability and Statistical Analysis	6 ____, 17 ____, 18 ____		9		
Design and Measurement	Inquiry 1 ____		10		
Periodic Functions	7 ____, 19 ____, 20 ____		8		
Sequences	Inquiry 2 ____		9		

APPENDIX C—Sheets for Marking the Inquiry Tasks

Inquiry Task 1: Design and Measurement		Booklet Numbers				
a)	1 mark for appropriate work for length of wood					
	1 mark for correct minimum length of wood					
	1 mark for correct minimum area of glass					
b)	1 mark for appropriate work					
	1 mark for correct answer					
c)	1 mark for correct maximum number of pieces of glass consistent with area in a)					
d)	1 mark for appropriate work for length of wood					
	1 mark for number of strips of wood consistent with answers in a) and c)					
	1 mark for total cost					
e)	1 mark for dividing by the number of frames consistent with answer in d)					
	Totals					

Inquiry Task 1: Design and Measurement		Booklet Numbers				
a)	1 mark for appropriate work for length of wood					
	1 mark for correct minimum length of wood					
	1 mark for correct minimum area of glass					
b)	1 mark for appropriate work					
	1 mark for correct answer					
c)	1 mark for correct maximum number of pieces of glass consistent with area in a)					
d)	1 mark for appropriate work for length of wood					
	1 mark for number of strips of wood consistent with answers in a) and c)					
	1 mark for total cost					
e)	1 mark for dividing by the number of frames consistent with answer in d)					
	Totals					

Use check marks (✓) to tally students' marks on the question.

Inquiry Task 2: Sequences		Booklet Numbers				
a)	1 mark for appropriate work					
	1 mark for correct answer					
b)	1 mark for correct graph consistent with work shown in a)					
	1 mark for correct labels and x-axis at a minimum of 16 doses					
c)	1 mark for correct answer					
d)	1 mark for appropriate work					
	1 mark for correct answer					
e)	1 mark for description of medication schedule so that the quantity of medication stabilizes between 1000 mg and 1200 mg inclusive					
	1 mark for appropriate work					
	Totals					

Inquiry Task 2: Sequences		Booklet Numbers				
a)	1 mark for appropriate work					
	1 mark for correct answer					
b)	1 mark for correct graph consistent with work shown in a)					
	1 mark for correct labels and x-axis at a minimum of 16 doses					
c)	1 mark for correct answer					
d)	1 mark for appropriate work					
	1 mark for correct answer					
e)	1 mark for description of medication schedule so that the quantity of medication stabilizes between 1000 mg and 1200 mg inclusive					
	1 mark for appropriate work					
	Totals					

Use check marks (✓) to tally students' marks on the question.

APPENDIX D

Irregularities in Standards Tests

A Guide for Local Marking

The *Administration Manual for Supervising Teachers* and the *Policies and Procedures for Standards Tests* are distributed to teachers and administrators to ensure consistency in the administration of standards tests. These documents deal with the issues of test material security and the Department's policy regarding adaptations and exemptions.

During the marking of standards tests, markers have occasionally encountered test booklets in which there have been irregularities. The following list provides examples of such irregularities, and is not intended to be exhaustive:

- Completely different penmanship in the same booklet
- Incoherent work with correct answer(s)
- Notes from a teacher indicating how he or she has assisted students during the test administration
- Student offering that he or she received teacher assistance for a question
- Student submitting work on unauthorized paper
- Evidence of plagiarism or cheating

If a student's mark on the test is 0% because he or she left the whole test booklet blank or answered with a combination of non-responses and inappropriate responses, please complete an *Irregular Test Paper Report* to confirm that the result is accurate (i.e., the student was not, in fact, absent or exempted).

Please note that student comments or responses indicating that the student may be at personal risk of being harmed or of harming others are personal safety issues. This type of student response requires an immediate and appropriate follow-up action at the school level. In this case, please ensure the Department is made aware that a follow-up has taken place by completing an *Irregular Test Paper Report*.

Except in the case of cheating or plagiarism where the result is a standards test mark of 0%, it is the responsibility of the division or the school to determine how they will proceed with irregularities. Once an irregularity has been confirmed, the marker prepares an *Irregular Test Paper Report* documenting the situation, the people contacted, and the follow-up. The original copy of this report is to be retained by the local jurisdiction and a copy is to be sent to the Instruction, Curriculum and Assessment Branch along with all other test materials.

Irregular Test Paper Report

Test: _____

Date marked: _____

Booklet ID No.: _____

Problem noted: _____

_____

_____

_____

_____

_____

Question(s) affected: _____

_____

_____

Action taken or rationale for assigning marks: _____

_____

_____

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Follow-up: _____

_____

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_____

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Decision: _____

_____

_____

_____

_____

_____

_____

Marker's Signature: _____

Principal's Signature: _____

For Department Use Only—After Marking Complete

Consultant: _____

Date: _____